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COMMUNICATIONS

INTRA-OCULAR ACRYLIC LENSES*

A RECENT DEVELOPMENT IN THE SURGERY OF CATARACT

BY

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EXTRACTION of the human lens for cataract has been performed with various improvements and increasing success for just 200 years. Daviel (1748) reported the first planned extraction but, as is frequently the experience of pioneers, his operation did not at first prove popular and most surgeons continued to couch cataracts, dislocating the opaque lens within the eye as had been practised in various countries with some measure of success since 1000 B.C. The discovery of cocaine as a local anaesthetic in 1884 rendered intra-ocular operations on elderly people less hazardous as well as painless, and from that time cataract ceased to lead almost inevitably to blindness. The extracapsular extraction which left in place the posterior lens capsule seemed for many years the only practicable operation and to this day, with its many improvements in technique, still has an honoured place in surgery.

At first the surgeon would not operate until the cataract was mature, when it could be completely expressed, but this entailed the patient waiting perhaps years in almost complete blindness until courage was found to operate. Later, with improvements in asepsis, it was found that if any soft cortex remained after expression of the nucleus it could safely be removed by irrigation with normal saline. Earlier operation could therefore be undertaken without great risk of post-operative iridocyclitis and with a reasonable chance of a clear pupil. Later still, anterior capsulectomy further improved technique and diminished the need for capsulotomy of "after cataract"; for the posterior capsule is extremely thin and, in the absence of the anterior capsule and remaining lens cortex, seldom requires division. The modern extracapsular extraction gives very good results, and the intact posterior capsule is a useful bulkhead in the eye, preventing forward bulging or prolapse of the vitreous and reducing the risk of detachment of the retina.

Early in the 20th century intracapsular extraction was introduced by Smith, Elschnig, and others, but for many years this operation, which permits removal of very immature cataracts, was regarded by many as unjustifiably dangerous, and it is only recently that it has become more popular than the well-tried and generally satisfactory extracapsular extraction. This procedure, though accompanied by considerably increased risk in the hands of inexperienced operators, is, within its limitations, practically the ideal, and

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with the development of modern technique perfection of cataract extraction has been attained. The defective part is completely removed in one stage through a wound which heals with an invisible scar.

Extraction is, however, but halfway to a cure, which is complete only when the important portion of a highly specialized organ is replaced.

Disadvantages of Aphakia

There are many disadvantages of aphakia. Accommodation is inevitably lost, but this is normal and physiological in most patients of cataract age. Ordinary cataract glasses, generally of the order of + 11 D are unsightly and heavy, and without them, as for instance when washing or bathing, the patient is practically blind. Moreover, serious optical disadvantages ensue, even with the latest " best form " patterns, for they only function at their best when the eye looks directly through the centre of the lens. Oblique views produce aberration and apparent displacement of objects which may cause patients to miss their step and to feel unsafe in traffic, so that although 6/6 vision may usually be obtainable the sight is not in practice so satisfactory as this high acuity would suggest. Furthermore, since to avoid touching the eyelashes the spectacle lens has to be beyond the anterior focal point of the eye, the image on the retina is magnified by about 33 per cent. In conjunction with the aberrations this renders binocular vision impossible if the other eye has not undergone cataract extraction, and it is frequently found that patients will persist in using an eye with acuity perhaps as low as 6/24 in preference to the aphakic eye which can read 6/6. Binocular difficulties are to some extent reduced by the use of a contact lens, the image of the aphakic eye being increased by only 15 per cent., but the majority of cataract patients have not the ability to insert these or the perseverance to continue their use on account of their tendency to cause irritation and " veiling ".

Replacement of Lens

Attempts have been made since 1949 to complete the surgical cure of cataract by replacing the missing lens. A heterogeneous human lens graft seems impracticable though, judging by the comparative success of corneal grafts composed of similarly avascular tissue, this would not appear to be beyond the realm of possibility. The difficulties of inserting a normal lens without damage within the recipient eye appear immense and there can be no certainty that, if inserted, it would be suitably nourished and remain clear. It would seem, however, from our present knowledge of artificial lenticuli that it might well stay in place, unlike a lens traumatically dislocated where the supporting vitreous is always deranged.

At present, therefore, an artificial lenticulus is the only solution. The problems to be solved were three: to select a transparent material which would not set up a tissue reaction in the eye, to determine the size and

refractive power of the artificial lens, and to devise a method of inserting it and retaining it accurately in position within the eye.

COMPOSITION OF THE ARTIFICIAL LENTICULUS.—The choice of material is between glass and " plastic " methacrylate compounds. Both these substances are known to be chemically inert in tissue fluids. It is well recognized that fragments of glass can remain in an eye indefinitely unless a sharp edge rests in contact with a sensitive and mobile part such as the iris, and there are many instances of eyes containing glass particles being examined by competent ophthalmic surgeons without the presence of the transparent foreign body being suspected. Rather less is known about acrylic compounds, though some experience has been gained from war wounds, especially those in which a perspex aircraft cover has been fractured by a bullet. These compounds too have been used successfully for some time for filling gaps in bone, not only in the skull but also in joint cavities where movement and the presence of synovial fluid to some extent resemble conditions within the eye.

Glass and acrylic compounds have much in common in addition to being inert in body fluids. Both are almost perfectly transparent and can be worked to a high degree of accuracy both mechanically and optically. Though less hard and therefore more easily scratched, methacrylate has the overwhelming advantage of light weight, its specific gravity being only half that of glass and not greatly in excess of the aqueous fluid.

Polymethyl methacrylate, generally known as Perspex (or Plexiglass), is now widely used in many industries. There are several varieties, and the manufacturers, Imperial Chemical Industries, have advised that their product Transpex I is the least likely to set up irritation in the body. This is a form of fully polymerized perspex with which the risk of gradual liberation of excess free monomer is eliminated. Moreover its composition and optical properties are more reliable than those of other varieties. Its refractive index is 1.49 and its specific gravity 1.19. It cannot be boiled without risk of distortion, neither is it resistant to certain chemical agents such as alcohol and formaldehyde. 1 per cent. cetrimide however, does not affect the material, and lenses may be sterilized by immersion in this fluid for at least one hour, after which they are thoroughly rinsed in distilled water.

DEVELOPMENT OF THE ARTIFICIAL LENTICULUS.—The object of inserting the artificial lenticulus to date has been to restore the eye to its pre-cataractous state so that, if the other eye is normal or nearly so, the refraction of the two will be approximately equal and will permit the return of single binocular vision. A standard lens has therefore always been employed, though in the future it may be advantageous to design and manufacture lenticuli to individual specification to obtain post-operative emmetropia when both eyes are to receive intra-ocular lenses and where the pre-cataractous refraction is accurately known.

The design of an artificial lens to copy the human might at first appear relatively simple, but such is not the case. The living human lens is a complex structure made up of differing anterior and posterior capsules and various distinct layers in both cortex and nucleus. Since it is not homogeneous it has no constant refractive index, though the approximate calculation is 1.42. Its refractive power is uncertain and has been variously estimated by different authorities as from +16.01

dioptres (Tscherning) to +19.11 (Gullstrand) when accommodation is relaxed. Moreover it is doubtful if an artificial lens would occupy precisely the same situation in the eye as the natural one, and in a compound lens system of short focal length a small difference of position is clearly of considerable refractive moment.

The lenses* have each been individually cut and ground from solid Transpex I to fine limits of accuracy. It was decided, for ease of insertion and to avoid undue pressure on the ciliary region which might tend to cause both cyclitis and obstruction of the filtration angle, to make the lens 8.35 mm. in diameter, approximately 1 mm. less than the normal human lens. The earliest lenticuli were constructed with the anterior and posterior curvatures similar to those attributed to the normal human lens, *i.e.*, anterior curve radius 10 mm., posterior curve radius 6 mm. A peripheral notch was cut with an ampoule file on both sides in one area of the periphery so that the prosthesis could be firmly grasped with toothed forceps. This lens proved to be too strong, and to render the eye myopic. Experience was gained, however, as it could be in no other manner, and at the third attempt the present specification was achieved which is found to provide a close approximation to the effect of the natural lens in the eye.

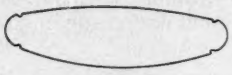

FIG. 1.—Section of intra-ocular acrylic lens. Anterior surface upwards.

FIG. 2.—Profile of blades of lens-insertion forceps. Slotted tip firmly grasps grooved edge of acrylic lens.

SPECIFICATION OF THE ACRYLIC LENS.—The artificial intra-ocular lenticulus at present in use is made of fully polymerized polymethyl methacrylate, Transpex I (I.C.I.). It measures 8.35 mm. in diameter and 2.40 mm. in thickness. The radius of the anterior curve is 17.8 mm. and of the posterior curve 10.7 mm. (Fig. 1). At the periphery on both sides a circumferential groove is cut before polishing to permit it to be grasped firmly in forceps. The refractive power of this lens in air is +74 D but in a medium of refractive index 1.33, such as the aqueous fluid, it is +24 D. The dimensions are about 1 mm. less than those of the human lens, and it is clear that its anterior and posterior refracting surfaces cannot be in the usual positions within the eye and differ from those of the natural lens in relation to the cornea, the retina, and each other. It is found, however, that the compound system composed of cornea and acrylic lens closely and consistently approximates to the normal, as judged by the refraction of the other eye. The machine-cut peripheral groove is superior in accuracy to the original hand-cut linear slots, and has the great advantage that, if necessary, the lens could be removed from the eye at the time of insertion, or at a later operation necessitated by complications, the prosthesis being grasped with forceps at any region of the periphery instead of at only one. Special forceps† for inserting the lens (Fig 2) cause less obstruction and provide a firmer grip than the 5-toothed fixation-forceps originally used.

It is important that the lens be inserted with its less curved surface nearest the

* These lenses have been made throughout by Rayner and Keeler, Ltd., 100 New Bond Street, London, W.1.
† These forceps are manufactured by John Weiss and Son, Ltd., 287 Oxford Street, London, W.1.

cornea. This surface can be distinguished in profile if the lens is held in forceps, and a useful check is to observe reflections on it from a source of light such as a window or the operating lamp. Two reflections are seen, one from each surface of the lens ; when these are markedly dissimilar in size the less curved anterior surface is in front, when nearly similar the posterior. A special metal rack* has also been designed, in which the prostheses may be sterilized in 1 per cent. cetrimide, thoroughly rinsed, and held undamaged in position until required (Fig. 3). It is advisable to set two correctly orientated lenses in the rack in case one should be dropped. If the lens is not set beforehand it may be difficult to distinguish the anterior surface rapidly during the operation and a mistake would be serious.

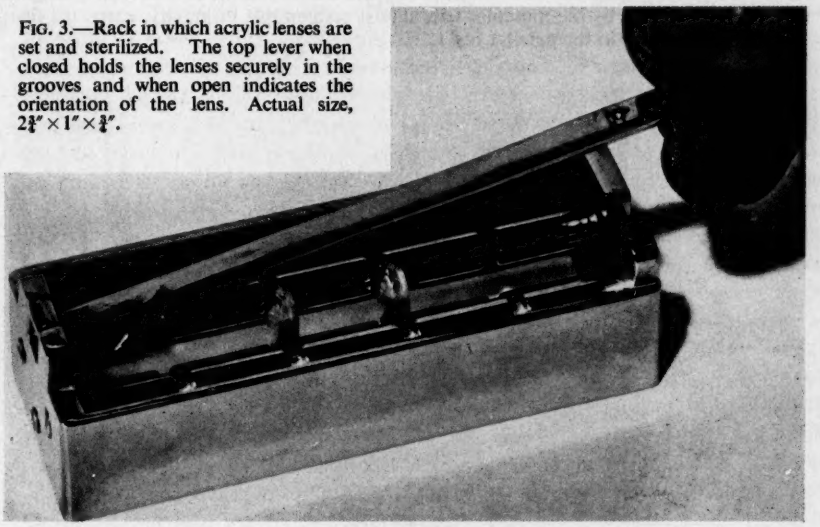

FIG. 3.—Rack in which acrylic lenses are set and sterilized. The top lever when closed holds the lenses securely in the grooves and when open indicates the orientation of the lens. Actual size, 2¾″ × 1″ × ⅜″.

TECHNIQUE OF CATARACT EXTRACTION AND INSERTION OF ACRYLIC LENS

Extracapsular cataract extraction is at present recommended, though the intracapsular technique has been used successfully in two cases. The pupil should be dilated to at least 5 mm. diameter with homatropine only. Full dilatation is by no means essential, for the curved edge of the acrylic lens will widen the iris aperture. Procaine 4 per cent. is injected over the neck of the mandible to block the upper branches of the facial nerve which supply the orbicularis muscle, and a simple lid stitch is inserted to ensure closure of the eye after operation. Anaesthesia is provided by 4 per cent. cocaine drops, no retrobulbar injection being required. Two half-depth corneo-scleral mattress sutures are inserted and an otherwise normal cataract section is cut, including where possible a small conjunctival flap (the writer does not in ordinary extractions find any sutures desirable). Very careful and complete removal of the central anterior lens capsule is effected with toothed capsule-forceps and, after expression of the lens nucleus, all cortical remnants are thoroughly removed by irrigation with normal saline. If it is decided that the posterior capsule has been completely cleared, the acrylic lens may be inserted forthwith ; if not, it is advisable to close the eye and to insert it at a second operation some weeks later. Assuming that the posterior capsule has been cleared, the acrylic lens is grasped by its

* These racks are manufactured by Rayner and Keeler, Ltd.

peripheral groove with the special forceps and removed from the lens holder with its anterior surface upwards. The corneo-scleral section is opened by an iris repositor held in the surgeon's other hand, and the acrylic lens is guided into the eye downwards and backwards with a slight side-to-side movement so that it enters the pupil, and partly lies beneath the lower portion of the iris (Fig. 4). The forceps can then, and only then, be relaxed, and the lens is steadied by the repositor while the sides and upper portion of the iris are manipulated over it with the point of a hook* or cystitome (Figs 5 and 6). Final centring is effected by external pressure on the cornea and sclera by iris repositors. A small peripheral iridectomy is now made, and, after a final irrigation of the anterior chamber, the corneo-scleral sutures are tied. Penicillin is instilled ; it is no longer considered generally necessary or advisable to use miotics, and both eyes are padded for 48 hours. The patient is allowed out of bed on the third or fourth day and the sutures are removed on the eighth day. Even pressure by the muscular iris, almost comparable to gravity, keeps the light lens securely upright in the patellar fossa.

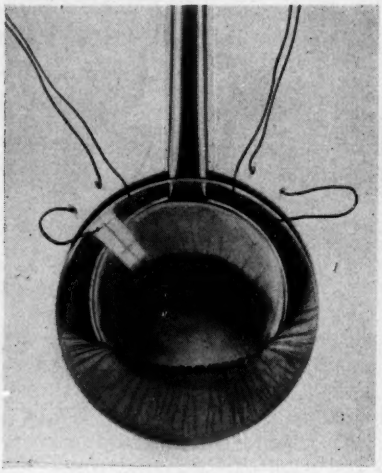

FIG. 4.—Insertion of acrylic lens beneath lower part of iris.

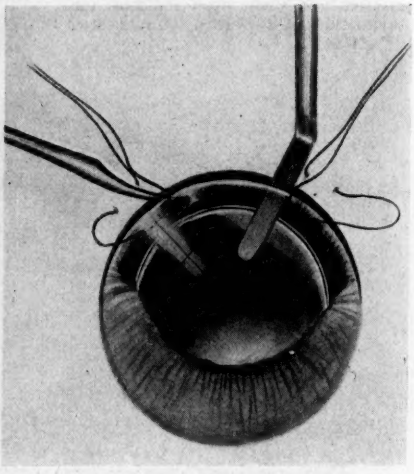

FIG. 5.—Upper part of iris hooked in front of acrylic lens, which is held steady by an iris repositor.

COMPLICATIONS.—The operation is clearly more difficult than plain cataract extraction, but the improved technique described is within the power of an ophthalmic surgeon with good experience. Very little trouble has, so far, been encountered, even with two intracapsular extractions in which vitreous loss might seem not improbable.

FIG. 6.—Iris hook. This resembles a Moorfields cystitome but has no cutting edge. The platinum stem can, if necessary, be bent to any shape to manipulate inaccessible regions of the iris.

The key to success is to insert the lens through the pupil and beneath the lower portion of the iris. If the forceps grip is relaxed when the entire lens is still in the

* Obtainable from John Weiss and Son, Ltd.

anterior chamber it is advisable to re-grasp and insert it again, for manipulation of the lower portion of the iris over the lens, though feasible, is very difficult. The special iris hook has a platinum stem which may be readily bent to facilitate this manœuvre if necessary. Judging by present results, there seems to be no risk that the lens, once properly inserted, will dislocate. It is, in fact, surprising how little the refraction alters once the eye has healed, for even a slight tilt of a powerful lens would inevitably produce marked astigmatism.

There is clearly a danger that the posterior capsule may thicken or wrinkle and require capsulotomy as in simple extracapsular extractions. This is relatively unlikely if a large area of anterior capsule is removed and great care is taken to wash away all cortical remnants. It should be remembered that the middle of the posterior capsule, which unlike the anterior is a simple hyaline membrane, is exceedingly thin—having a thickness of only 4 microns. Furthermore, the presence of the acrylic lens tends to keep it taut and free from wrinkles. In only one case to date has it seemed advisable to divide the posterior capsule. This was in an early case in which the lens employed proved to be too thick and powerful. Capsulotomy was performed by inserting a Ziegler's knife through the sclera well behind the lens, and by cutting from behind forwards under direct observation through the pupil. There is clearly some risk of scratching or dislocating the acrylic lens and fortunately there has so far been no need for this operation on other cases. If posterior capsule thickening is feared, central capsulotomy might be performed before the lens is introduced.

Two surgical misfortunes have to be reported. In Case 1, in which too large a lens was inserted and corneo-scleral sutures were not used, an iris prolapse occurred. By good fortune, however, the eye settled and is capable of seeing 6/18, though only with the aid of a strong concave spectacle lens in addition. In Case 15, a somewhat feeble old man of 75, the corneal section failed to unite in the usual time, and when the sutures were removed the aqueous was lost; this caused the iris to adhere to the wound and led to the formation of a "false filtration angle" and to glaucoma.

As with simple extracapsular extractions, slight serous iritis frequently follows the operation, and there is a tendency for the pupillary margin of the iris to adhere to the lens for a while and for exudate to be deposited on the middle of the anterior lens surface. This mild inflammatory phase is transient, however, and the fibrinous deposits disperse, especially if miotics are avoided and if subconjunctival cortisone is given. It is quite surprising how clear these eyes become and remain, and there has been no instance of persistent or recurrent iritis. Miotics, employed at first to prevent forward dislocation of the lens, are no longer considered necessary, for the presence of the prosthesis seems just sufficient stimulus to maintain iris tone and keep the pupil less than half dilated.

The two intracapsular operations were performed with some misgivings, for there was no membrane to prevent prolapse of vitreous or to line the patellar fossa and form a firm background against which the gentle iris pressure would be exerted. No trouble has, however, been experienced either at the operations or since, though the risk of lens dislocation as a result of minor trauma still causes anxiety.

RESULTS

So far 27 eyes have undergone this operation at St. Thomas's Hospital and Moorfields, Westminster and Central Eye Hospital since November, 1949. The early cases were carefully selected and only those in which the cataract was completely monocular were chosen. It was felt that these had less to lose should failure ensue and much to gain from success, for, in addition to freedom from the need for spectacles, the reward was restoration of binocular vision. The possible dangers of the operation were explained to the patients. As a result acrylic lenses were inserted in only eight eyes in the first 18 months but the encouragement provided by these early cases, observed for a considerable period, justified less stringent selection and the operation has now been performed on patients between the ages of 12 and 84 years. The 27 cases are tabulated on the opposite page.

The first two cases form a separate group, for not only was the operative technique untested but the acrylic lens, as already mentioned, was too thick and of too high refractive power. The first case, in which no corneo-scleral sutures were used, developed iris prolapse, but the other was technically satisfactory. Moderate acuity is now obtainable but only with the aid of a high concave spectacle lens which renders the result no better, though little worse, than that of a simple extraction of monocular cataract.

The remaining 25 eyes all contain an acrylic lens of the present specification, and only one, the old man of 75 (Case 15) whose section was slow to heal, has given trouble. The others are all successful in that binocularly the sight is better than with simple extraction alone. A more exacting criterion of success, however, is to judge the eye individually and not as one of a pair, to judge in fact the performance of the organ rather than the performance of the patient.

These 24 are surgically satisfactory and have central and circular or nearly circular pupils, lenses in good position, normal tension, and no active inflammation. In some, however, the presence of varying amounts of exudate and iris pigment on the lens surface still partly obstructs vision, but in every case improvement is occurring, and it is not beyond hope, though there is no certainty, that all will become clear in due course. So far two eyes can see 6/36 letters, one 6/24, three 6/18, two 6/12, five 6/9, five 6/6, and two 6/5. (One 6/36 eye is technically perfect with an intracapsular extraction but was found to suffer from myopic degeneration.) The four most recent cases have not yet been tested for acuity. Many of these eyes have undergone operation comparatively recently, and further improvement in acuity is confidently anticipated. With three exceptions, cataract extraction and acrylic lens insertion were performed at one operation. Of the two-stage operations, one was on a 12-year-old boy (Case 12) who had had an intra-ocular foreign body. Here an adhesion between the perforating wound of the iris and the underlying lens capsule causes some distortion of the pupil, but acuity of 6/9 is obtained and the eye is free from inflammation.

REPORTS OF 27 CASES OF ACRYLIC LENS INSERTION

Hospital	Case No.	Age and Sex	Date of Operation	Present Refraction and Acuity: Operated Eye	Present Refraction and Acuity: Other Eye	Remarks
Series 1						
S.T.H.	1	45 F	29.11.49	Left $\frac{-18.0\ DS}{-6.0\ dc,}$ ax 120—6/18	−0.25 DS—6/6	Iris prolapse. Eye now quiet.
M.W.C.E.H.	2	46 F	23.8.50	Right $\frac{-14.0\ DS}{-2.0\ dc,}$ ax 60<6/60	1.0 DS—6/5	Pre-operation irido-cyclitis. Tension+
Series 2						
M.W.C.E.H.	3	59 F	17.11.50	Right $\frac{-10.0\ DS}{-1.0\ dc,}$ ax 90—6/18	−9.0 DS—6/12	Two-stage operation.
M.W.C.E.H.	4	58 F	17.11.50	Right $\frac{+4.0\ DS}{+1.0\ dc,}$ ax 135—6/12 part	$\frac{+2.25\ DS}{+0.5\ dc,}$ ax 90—6/5	
S.T.H.	5	41 F	1.3.51	Right $\frac{-1.5\ DS}{-1.5\ dc,}$ ax 60—6/6	unaided 6/5	
M.W.C.E.H.	6	32 M	6.4.51	Left unaided 6/24	+0.25 DS—6/5	Fundus clearly visible, should see more.
M.W.C.E.H.	7	50 M	20.6.51	Right unaided 6/18	unaided 6/5	Much pigment on lens, clearing.
S.T.H.	8	40 M	10.5.51	*Right −0.5 DS—6/5*	*unaided 6/5*	*Right eye 6/6 unaided.*
M.W.C.E.H.	9	59 M	24.7.51	Left $\frac{-1.5\ DS}{-1.5\ dc,}$ ax 90—6/5	*+1.0 DS—6/5*	
S.T.H.	10	62 F	25.7.51	Right $\frac{+0.5\ DS}{-1.0\ dc,}$ ax 180—6/9	$\frac{+0.5\ DS}{+1.5\ dc,}$ ax 90—6/9	
S.T.H.	11	63 F	25.7.51	Right $\frac{-1.0\ DS}{-2.0\ dc,}$ ax 75—6/6	−0.5 DS—6/6	
S.T.H.	12	12 M	8.8.51	Left $\frac{-1.5\ DS}{-1.5\ dc,}$ ax 90—6/9	unaided 6/6	Left traumatic cataract. Intra-ocular foreign body, 1947.
M.W.C.E.H.	13	80 F	10.8.51	Left unaided 6/9 part	+2.0 dc, ax 130—hand movements	Left cataract for acrylic lens.
S.T.H.	14	63 F	10.9.51	Right $\frac{+1.0\ DS}{+1.5\ dc,}$ ax 10—6/6	−1.0 DS—6/24	
M.W.C.E.H.	15	75 M	11.9.51	Left less than 6/60	unaided—6/60	Section gaped. Tension+
S.T.H.	16	65 M	17.9.51	Left −1.0 dc, ax 105—6/6 part	$\frac{-1.0\ DS}{-0.5\ dc,}$ ax 30—6/9	
S.T.H.	17	73 F	19.9.51	Right $\frac{-9.0\ DS}{-3.0\ dc,}$ ax 60—6/36	−1.0 DS—6/12 part	Intracapsular extraction. Monocular myopia.
S.T.H.	18	49 M	20.9.51	Left −4.0 dc, ax 45—6/36	+0.5 dc, ax 90—6/12	Much pigment on lens, clearing.
M.W.C.E.H.	19	51 M	21.9.51	Left unaided 6/9	+0.5 DS—6/12	
S.T.H.	20	71 M	3.10.51	Right $\frac{-4.0\ DS}{-3.0\ dc,}$ ax 90—6/12 part	Less than 6/60	Intracapsular extraction. Left eye for acrylic lens.
M.W.C.E.H.	21	63 F	25.9.51	Left $\frac{-6.0\ DS}{-2.0\ dc,}$ ax 135—6/9	$\frac{-6.0\ DS}{-5.0\ dc,}$ ax 45—6/12 part	
S.T.H.	22	60 F	29.10.51	Right $\frac{-2.5\ DS}{-1.5\ dc,}$ ax 100—6/6	$\frac{+0.5\ DS}{-1.5\ dc,}$ ax 30—6/9	
M.W.C.E.H.	23	82 F	6.11.51	Left +1.5 dc, ax 90—6/18	$\frac{+3.5\ DS}{+2.0\ dc,}$ ax 90—6/12	Much pigment on lens, clearing.
S.T.H.	24	84 F	3.12.51	Right not yet tested	Less than 6/60	
S.T.H.	25	82 M	13.12.51	Right not yet tested	Less than 6/60	Right eye distinguishes faces clearly now.
S.T.H.	26	84 F	17.12.51	Left not yet tested		Acrylic lens in second eye.
M.W.C.E.H.	27	74 F	21.12.51	Left not yet tested		

With the acrylic lens, the refraction is usually within 2 dioptres of the other eye, and often much less, a difference quite compatible with binocular vision. In some cases the spectacles worn before cataract developed can be used again with fair acuity (6/12). There is naturally no post-operative rivalry between the two eyes and patients generally appreciate binocular vision as soon as the acrylic lens eye can be used. The best result obtained, which may not be surpassed, is 6/6 unaided and 6/5 with — 0.5 D sphere.

Discussion

It is now known that it is possible to insert an artificial lens into the human eye and to retain it accurately in position, without giving rise to inflammation or to glaucoma, for at least 2 years. A satisfactory lens specification seems to have been evolved, though this may undergo modifications in the future. It is now possible, where the other eye is normal or relatively normal, for binocular vision to be regained with no external refractive aid or only slight assistance, and ordinary cataract patients need no longer suffer the disabilities inseparable from the use of very strong glasses. It is too soon, however, to claim that this operation, like others before it, renders earlier technique obsolescent, though this would not appear to be impossible. The early experimental stage has passed but over-confidence is certainly unjustified; simpler methods will continue to give adequate results and inevitably, from time to time, serious accidents may occur with the new operation, as in every branch of surgery. The new technique with future modifications may well be the best that can be evolved until biochemical and endocrinological research eventually teaches us how to prevent cataracts developing.

Summary

A new operation is described whereby an artificial lenticulus is inserted in the eye after cataract extraction. Excellent function can be obtained, and a lens has been known to remain in position without causing inflammation for at least two years.

My thanks are due to Mr. J. Pike of Messrs Rayner and Keeler Ltd., for his assistance in the design and manufacture of the acrylic lenticuli and lens rack, to Mr. A. G. Voigt of Messrs John Weiss and Son, Ltd. for constructing the lens-insertion forceps and iris hook, and to Imperial Chemical Industries for providing suitable polymethyl methacyrlate. I am also indebted to Col. F. R. B. Skrimshire for carefully determining the refraction and acuity of every case. Miss J. Trotman kindly made drawings of the operation.

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ORBITAL IMPLANTS*

REVIEW OF RESULTS OBTAINED AT THE MOORFIELDS BRANCH OF THE MOORFIELDS, WESTMINSTER AND CENTRAL EYE HOSPITAL, LONDON

BY

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London

ENUCLEATION of an eye is likely to remain one of the commoner ophthalmic procedures. Out of approximately 4,000 operations performed at the Moorfields branch of the Moorfields, Westminster and Central Eye Hospital in 1950, 200 were for excision of an eye. A number of these were blind, painful eyes—thrombotic glaucoma, for example—in elderly people, in whom cosmetic considerations would be satisfied by an ordinary painted shell for the socket. These patients were commonly very grateful for the operation. Many of the remaining eyes were excised either after severe injury resulting in a disorganized and possibly dangerous globe, or for choroidal sarcoma. Here the patients not only lose what may well be a good seeing eye, but they are also much concerned with their post-operative appearance. Many of these patients are young, with their careers before them, and their future could well be affected by having an obviously false eye.

The recent war stimulated a great deal of work on movable ocular prostheses. Buried implants—of glass, ivory, and more recently of plastic material—impart an appreciable amount of movement to an overlying shell, provided that the muscles are sutured to or across the top of the implant. Nevertheless, recent work has moved away from the concept of the buried implant in favour of the integrated implant, in which the anterior surface is left exposed for direct contact with the painted shell (Reudemann, 1945; Cutler, 1947, 1949; Hudson, 1950; Stone, 1951). However, a search of the literature has failed to disclose any concrete statistics concerning the survival rate of these unburied implants. The nearest approach is contained in a personal communication from Stone (1951), who states:

> 136 post-enucleation implants have been placed during the past 3½ years. There have been no extrusions up to the present time. The implant is fashioned of methyl methacrylate and partially covered by a tantalum meshwork . . . there have been no infections behind the implant in the series.

This is a very remarkable achievement. It is not stated, however, how many of the 136 implants have been personally inspected by the surgeon concerned, and at what interval after insertion. Nor is it stated how many were placed 2 to 3 years ago and how many within the last 12 months.

Drucker and others (1951) reviewed the results obtained with both buried and unburied implants from the years 1946-1950, basing their remarks on

* Received for publication December 12, 1951.

the answers to a questionnaire sent to four of the leading eye hospitals in the United States. The picture given is very different from that provided by Stone.

There were many practical difficulties in arriving at an accurate assessment of the results: owing to the migratory habits of the patients, only 50-60 per cent. of them were successfully traced; there was a wide variation in the details provided by the different institutions; and a large number of different types of implant were in use. Statistically, Drucker and others' results cannot be regarded as accurate. Nevertheless, certain statements in their paper stand out. For example :

> Between March, 1946, and March, 1947, 23 (unburied) Cutler ring-type implants were inserted at the Wilmer Institute. Fifteen of the 21 primary implants were extruded on the average 6 months later; the remaining six were satisfactory after an average follow-up of 29 months.

Elsewhere in the paper it is stated that:

> Troublesome secretion, recurrent granulations, and chronic infection were of common occurrence in surviving implants.

Experience with the buried implants (Hoffman, Allen, Troutman Magnetic) was on a much smaller scale, and none of the authors committed themselves in any way. It would appear, however, that extrusions were few, but that mobility was not so good as with the unburied implants.

Scope of the Present Investigation

By the end of 1950, 99 implants of varying types had been inserted at the Moorfields Branch of the Moorfields, Westminster and Central Eye Hospital. This number was made up as follows :

Hollow tantalum (Fig. 1)	76
Gold ring and cylinder (Fig. 2)	21
Solid tantalum	2

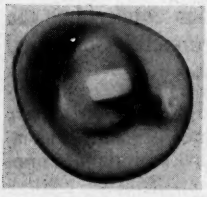

FIG. 1.—No. 13 tantalum implant. Posterior surface of mobileye showing peg.

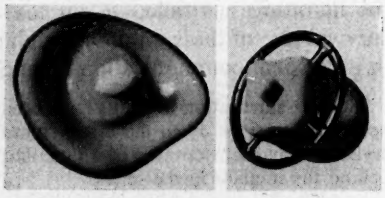

FIG. 2.—Gold ring and cylinder implant. Posterior surface of mobileye showing peg.

The anterior surface of all these implants was left exposed for direct contact with the posterior surface of the painted shell.

They have all been followed up to the end of 1951, so that none of the implants has been watched for less than 12 months. The following have been excluded from this survey :

One solid tantalum implant worked out 10 months later and was replaced by a hollow tantalum implant.

One hollow tantalum implant used to replace a gold ring implant which was working out.

One gold ring implant used to replace a hollow tantalum implant which was working out.

One hollow and one solid tantalum implant placed inside the sclera after evisceration to which the muscles were not attached directly as was the case with the remaining implants under review.

One hollow tantalum implant introduced 20 years after enucleation of the eye for retinoblastoma.

Two gold ring implants in patients who died of metastases from choroidal sarcoma 6 months and 2 years respectively after operation. No information could be obtained about the state of the implant in these cases.

One gold ring implant and one hollow tantalum implant not able to be traced.

Excluding the above cases, there remain to be considered seventeen gold ring and 74 hollow tantalum implants. Altogether 98 per cent. of the total number of implants introduced have been successfully traced.

Technique of Insertion of Implant

A number of different operating surgeons have contributed to the cases here surveyed. Obviously, the operative technique varied in detail from surgeon to surgeon, but in all cases the principle remained the same, namely :

attachment of the four recti muscles to the gold ring or the tantalum mesh as the case might be, separate provision being made for Tenon's capsule and the conjunctiva.

Some surgeons carefully suture Tenon's capsule to the mesh and then the conjunctiva separately further up the mesh ; others disregard Tenon's capsule and merely suture the conjunctiva to the mesh ; an even simpler technique is to suture the conjunctiva over the implant with a purse-string suture. The conjunctiva soon retracts and takes up an attachment to the mesh further back. Hudson (1950) splits the muscle tendons and unites half of each to half of its neighbour, leading to the development of a fibro-muscular ring round the neck of the tantalum implant and thus reducing still further the likelihood of a later extrusion of the implant.

However, the actual technique employed does not seem to matter much, if one is to judge by the results, since those of each surgeon approximate closely to those of his colleagues.

Method of Conducting Survey

The cases were divided according to whether or not the implant was still *in situ*. If not, the cause of loss was investigated ; if so, the implant was examined as to movement, amount of discharge, presence or absence of granulations, and amount of mesh or gold ring exposed. An attempt was made to classify the implant as to prognosis as follows :

Grade I.—The implant looked as though it should stay in indefinitely. This accolade was reserved for those cases in which no mesh or gold ring (as the case might be) was

exposed, there was no discharge, there were no granulations, and there were good movements in all directions.

Grade II.—The implant looked as though it might stay in for another year or so. The criteria were the same as for Grade I, except that a moderate amount of discharge and some granulations were present and a small amount of mesh or gold ring was exposed.

Grade III.—The implant looked as though it would not be long before it either worked out or had to be removed. In this grade were placed implants in which much of the mesh or gold ring was exposed and there was considerable discharge and much granulation tissue.

Although this assessment is admittedly an arbitrary one, considerable importance is attached to this method of estimating the prognosis of implants, as will be seen later.

Gold Ring and Hollow Tantalum Implants

Immediate Results.—Most surgeons will agree that the immediate results of both types of implant are excellent. When an adequate painted shell has been fitted it takes an expert observer several seconds at least to determine which is the artificial eye, so good is the cosmetic result and so accurately do the movements of the prosthesis follow those of the sound eye. In a good case the implant moves fully in all directions, the excursion being limited only by the prosthesis impinging upon the orbital margin. The tiny " conversational " movements are present, and the implant may even converge when the sound eye accommodates for near objects. For ordinary social purposes these implants are more than adequate, and have been of great help in such occupations as teaching, where it is a considerable handicap to have an obviously false eye.

Having reviewed all these cases, I am of the opinion that while the gold ring implants tend to discharge less, the hollow tantalum implants have a better range of movement and look more normal, because the gold ring implant is smaller and gives the impression of a degree of enophthalmos when fitted with its painted shell. However, these are but minor points, and the immediate results of both types of implant are excellent.

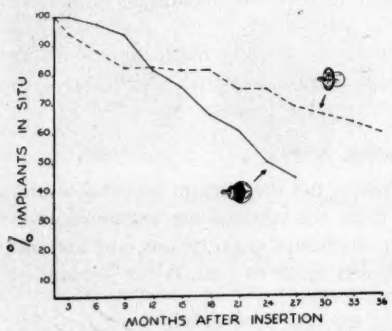

FIG. 3.—Survival rates of gold ring and hollow tantalum implants.

Delayed Results.—These can best be expressed graphically (Fig. 3). It will be seen that after the first 12 months there is a marked increase in the number of implants that come out. After 2 years, 75 per cent. of gold ring implants but only 50 per cent. of hollow tantalum implants were still *in situ.* As the number of gold ring implants reviewed was merely seventeen as compared with 74 of the hollow tantalum type, the difference of 25 per cent. in favour of the gold ring type cannot be regarded

as statistically significant. The impression remains, however, that the gold ring implant stays in rather longer than the hollow tantalum type. By the end of 3 years, however, the percentage of gold ring implants remaining was reduced to 60 per cent.

Prognosis of Surviving Implants.—26 hollow tantalum implants were reviewed 2 years after insertion, when thirteen were still *in situ*. The corresponding figures for the gold ring implants were twelve surviving out of sixteen. Table I illustrates the prognostic grading of the surviving implants according to the method oulined above.

TABLE I

Type of Implant	Grade		
	I	II	III
Gold ring	3	5	4
Hollow tantalum ..	2	7	4

In other words, out of 25 implants (thirteen hollow tantalum and twelve gold ring) still *in situ* 2 years after insertion, only five appeared to a critical judge to be likely to stay in indefinitely. Furthermore, the downward trend of both curves in Fig. 1 cannot be overlooked, and it would appear probable that 5 years after insertion only one or two implants at the most will still be *in situ*, the remainder having been rejected by the orbital tissues.

Causes of Loss.—35 implants (five gold ring and thirty hollow tantalum) are known to have been extruded or to have been removed. The reasons for loss are summarized in Table II.

TABLE II

Causes of Loss	No. of Cases
Chronic drug-resistant infection leading to gradual erosion of attachment of implant	21
Constant drug-resistant infection without exposure of gold ring or tantalum mesh	4
Recurrent acute orbital cellulitis involving long periods of hospitalization	2
Haemorrhage behind implant on fifth post-operative day, infection of haematoma led to loss of implant after 7 months ..	1
Implant " worked out ", element of infection probably present..	7

Some of these implants just " dropped " out, but the majority had to be removed surgically, which was quite an undertaking since so much dense fibrous tissue and haemorrhagic granulation tissue was present that a general anaesthetic was usually necessary. Biopsies of the socket lining in two cases failed to show any attempt at epithelialization.

Thus in 28 (80 per cent.) of the 35 cases, infection was primarily responsible for loss of the implant, and in the remaining 20 per cent. infection was probably a subsidiary factor.

It was of interest to observe which part of the implant loosened first. In 90 per cent. it was the superior rectus attachment. The remaining 10 per cent. were divided between the internal and external recti. In no case did the inferior rectus give way initially; this phenomenon was so marked that one might consider leaving the inferior rectus unsutured, thus permitting it to form its own attachment to the implant. It is not clear why the superior attachment was the first to suffer in so many cases. Although the hollow tantalum implant and painted shell weigh about 6 g., compared with 7 g. for the average eye, yet gravity would presumably act more on the former than on the latter. The superior rectus is always weaker than the inferior and possibly the extra strain imposed by gravity is felt most by the weaker muscle, particularly when this is attached by fibrous tissue to the implant and not by its normal tendon to the sclera.

This investigation disclosed that the fate of the implant was *not* affected by certain likely factors, for example, the age of the patient, the reason for enucleation, or the particular surgeon who performed the operation. There was no evidence of electrolytic action leading to corrosion of the metal.

Discussion

The results disclosed by this survey cannot be regarded as satisfactory. If half the implants come out within 2 years and the remainder perhaps during the next 2 to 3 years, it can hardly be considered an economic procedure either from the patient's standpoint or as regards the best use of the available hospital beds. Ophthalmic surgeons should not rest until they have been able to improve substantially on this figure.

Analysis of the causes of loss of the implant suggests very strongly that a state of chronic infection exists in all these unburied implants and that this infection eventually causes loss of the implant. The conjunctiva is presumably never able to form a bacteria-proof junction with the foreign body with which it is in contact and is thus unable to fulfil its traditional anti-bacterial role with success. It would be reasonable to think that the incidence of infection would be much reduced and the implant's chances of survival proportionately increased if Tenon's capsule and the conjunctiva were separately united over the implant, thus burying it completely.

The reaction of tantalum with the tissues must also be considered. Carney (1942) was the first to show that it was well tolerated by the tissues. Pudenz (1943) studied the fate of tantalum plates in the skulls of cats, and demonstrated that they were relatively inert in this situation. Lewin and others (1948) reported on 124 cases where tantalum plates were used to repair skull defects in war casualties. After 2 years, 94 were completely satisfactory, and eleven had been removed, including five for infection. The incidence of infection, both early and late, was 7 per cent. One would conclude from these figures that the continued use of tantalum plates in this situation would be justified.

Douglas (1948) reports on the use of tantalum gauze in the repair of large herniae, with good results, and Schultz and Fowler (1947) recommend its use in the cheek and lips, but McLaughlin (1949) reported failure in every case where tantalum wire was used in cases of facial palsy. He ascribed fragmentation of the wire to :

(*a*) electrolytic action between the wire and neighbouring metallic dental fillings, with consequent corrosion of the tantalum,

(*b*) alteration in the crystalline structure of the metal owing to continual stresses in the wire, such as would be caused by passive facial movements as in eating.

Parallel research has been going on into the use of acrylic resin (methyl methacrylate). Beck and others (1945) inserted acrylic disks into rabbits' skulls and noted very little reaction. Small and Graham (1945) reported on 25 cases where acrylic disks were used to repair skull defects in man, and in 24 the immediate results were satisfactory.

However, even if 50 per cent. hollow tantalum implants came out after two years, 50 per cent. stayed in, and in spite of the lack of certainty concerning the inertness of tantalum in the tissues, it would appear justifiable to proceed with *buried* tantalum implants. At the suggestion of Mr. F. A. Williamson-Noble, Messrs Theodore Hamblin Limited have constructed several different prototypes (Fig. 4), some of which have already been inserted, so far with results immediately satisfactory. One such case was shown at a recent meeting of the Ophthalmic Section of the Royal Society of Medicine.

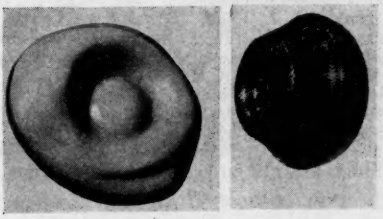

FIG. 4.—No. 14 tantalum implant for burying, note dimple on anterior surface. Posterior surface of mobileye showing nipple.

Tantalum is expensive, each implant costing £9–10, and in the interests of economy an effort should be made to develop an acrylic implant which would lend itself to this type of operation as readily as do the tantalum implants. Messrs John Weiss and Son Limited make one to the specification of Castroviejo, but no reports are available of its use in Great Britain.

Summary

(1) 98 per cent. of all the orbital implants inserted at the Moorfields Branch of the Moorfields, Westminster and Central Eye Hospital up to the end of 1950 have been followed up.

(2) 50 per cent. of the hollow tantalum implants came out after 2 years and 40 per cent. of the gold ring after 3 years. The prognosis of the surviving implants is reviewed and it is considered probable that only one or two implants at the most will be *in situ* 5 years after insertion.

(3) The predominant factor causing loss of these implants was found to be infection. It is considered that the infection was largely due to the fact that these implants were not completely buried.

(4) The position of tantalum and acrylic implants in plastic surgery is reviewed.

(5) It is suggested that the use of all unburied orbital implants be abandoned and that henceforth only buried implants either tantalum or acrylic be used.

(6) An interval of at least 3 years after insertion should elapse before the value of any new type of orbital implant is assessed.

My thanks are due to the Medical Committee of the Moorfields Branch of the Moorfields, Westminster and Central Eye Hospital for permission to peruse the hospital records and to publish the results of this investigation; to Dr. P. Hansell of the Department of Medical Illustration, Institute of Ophthalmology, for the graph and photographs; to Messrs Theodore Hamblin Ltd. for their co-operation; and to Miss White of the Registrar's Department at the Moorfields Branch, through whose efforts such a high percentage of the patients was successfully traced.

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PHASE-CONTRAST MICROSCOPY OF THE ANIMAL VITREOUS BODY*

BY

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A STUDY of the structure of the vitreous body has been made by means of phase-contrast microscopy. Shortly after work began, Schwarz and Schuchardt (1950) described the structure of the vitreous of various animals using this method as well as dark-ground illumination. However, it was thought worth while to continue our study as we were specially interested in trying to determine the chemical nature of the fibres and membranes seen, and their distribution within the vitreous body. The chemistry of the vitreous was not investigated by Schwarz and Schuchardt (1950). Later, however, following its examination with the electron microscope, Schwarz (1951) and Matoltsy and others (1951) concluded that one type of fibre from the vitreous body is probably a primitive collagen. This confirms the chemical analyses of the residual protein by Pirie, Schmidt, and Waters (1948).

The work described in this paper has been mainly concerned with the vitreous body of the ox. No wide investigation of other animals has been attempted, but it seemed worth while examining the vitreous body of birds as there is evidence that its embryological origin is different from that of mammals (Mann, 1949). We also examined the vitreous of the monkey, since that of man is almost impossible to obtain fresh and in the normal state.

Methods

In order to determine its structure, pieces of fresh vitreous were removed and examined, without further treatment, by phase-contrast microscopy. The various structures seen were then treated with enzymes in order to get information on their chemical composition.

Material.—The eyes were brought from the slaughterhouse within one hour of the death of the animal and were either stored in the refrigerator or used at once. In all cases, unless the contrary is stated, the description of the microscopic structure is based on the examination of absolutely fresh specimens. The method of opening the eye to get a piece of vitreous for examination depended on the site of the specimen needed, and is best described later under the separate headings. In all cases a small piece of the fresh vitreous *in situ* in the eye was grasped with forceps and cut off with scissors. It was then placed on a slide with a drop of

* Received for publication November 10, 1951.

saline, sometimes being teased to make as thin a preparation as possible, and a coverslip was put on. The preparation was immediately examined with a Beck positive phase-contrast microscope. The eyes of the pigeons and monkeys were removed immediately after the creatures were killed and were examined in the same way.

For photography a 90° positive phase-contrast microscope* was used, the objective in all cases being the 4 mm. N.A. 0.65.

Enzyme preparations used for treatment of the vitreous were :

Crystalline trypsin† made up 10 mg./ml. in phosphate saline *p*H 7;
Collagenase‡ from *Clostridium welchii* made up 2-4 mg./ml. in borate or saline *p*H 7;
Hyaluronidase extracted from acetone-dried rabbit testis with dilute acetic acid and used after neutralization and centrifugation.

Results

OX VITREOUS BODY.—We found three different structures within the vitreous body :

(1) coarse branching fibres attaching the vitreous body at its base;
(2) very fine parallel fibres running through the main body of the vitreous;
(3) a hyaline membrane surrounding the vitreous.

These structures would all be included in the preparations of residual protein made from whole vitreous body by filtration and washing. It seems therefore that "residual protein" is a mixture of substances and not a chemical entity.

Coarse Branching Fibres of the Ciliary Region.—To demonstrate these the sclera alone is incised half-way round the equator. A piece of sclera is then removed extending from the equator to near the limbus, thus forming a band-shaped window revealing the choroid. The latter is removed and then the retina, leaving the vitreous surface exposed. At the front edge of the window the tooth-like ciliary processes can be seen. If the cut edge of sclera near the limbus is gently pulled with forceps, parallel lines of strain can often be seen extending from the ciliary processes over the surface of the vitreous and into its substance, in much the same way as traction on the lens shows the lines of tension of the zonular fibres. A piece of vitreous body nipped off from this region contains coarse branching fibres whose thickness is about 0.5–3.0 μ. Typical preparations are shown in Figs 1 and 2. When such preparations are viewed by phase-contrast it is necessary to decide whether the structures seen are true fibres or merely creases in a membrane. In support of the former interpretation is the fact that the mode of branching which is quite frequently seen would be unlikely to occur in a crumpled membrane. Moreover, the free ends of the criss-crossing fibres can often be found (Fig. 1).

Many observers have noticed that the vitreous body is firmly attached to the ciliary processses; if it is pulled away from the sclera and choroid in this region a ring of pigmented processes tears off and remains adherent to the vitreous body.

* Made by Cooke, Troughton, and Simms. The photographs were taken by a Leica camera and Leica eyepiece camera attachment, the film being Kodak Microfile Panchromatic.
† Armour and Co., London.
‡ Prepared by Dr. R. O. Thomson, *Wellcome Research Laboratories.*

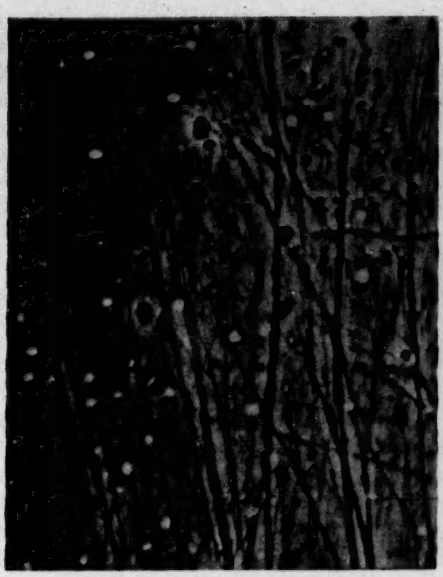


FIG. 1.—Ox, free ends of coarse fibres from ciliary region.

FIG. 3.—Ox, hyaline membrane of surface of vitreous body.

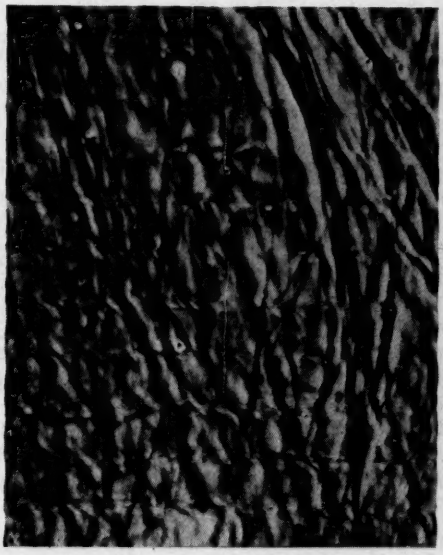


FIG. 2.—Ox, coarse branching fibres from ciliary region.

FIG. 4.—Ox, fine fibres lying in waves.

Phase-contrast photographs of the unfixed and unstained vitreous body. Approx. ×700.

It is possibly from these processes that the coarse fibres have their origin. The fibres are evidently a true part of vitreous structure. They not only run on the surface of the vitreous but also extend into its substance. Coarse branching fibres cannot be found in vitreous preparations from behind the equator or from the centre of the vitreous body.

Preparations of fresh vitreous such as those employed here do not reveal the direction in which the fibres run in the intact vitreous body. Schwarz and Schuchardt (1950) described fibres 1.3 – 2.9 μ wide as extending towards the centre of the vitreous, but since their preparations were made in the same way as our own it is difficult to see on what evidence this conclusion is based.

Fine Parallel Fibres.—If a small piece of fresh vitreous is removed through a scleral opening at or behind the equator and examined microscopically no coarse branching fibres are seen. Instead, there are strands of very fine parallel fibres which are sometimes straight (Fig. 5) and sometimes in waves (Fig. 4). These are particularly obvious if some of the fluid in the small piece of vitreous jelly is allowed to drip away before the preparation is put on the slide. We have stressed that microscopic preparations show the fibres to be parallel. In fact, the fibres are so fine that their fibrous nature can only be detected by the appearance of this parallel striation. Slight pressure of coverslip might make fibres connected in a network take a parallel course, as do the strings in a network string bag when the bag as a whole is stretched in one direction. Therefore, though we speak of the fibres as "parallel" fine fibres, it is not assumed that they exist in this arrangement within the vitreous.

Preparations showing these fibres can readily be made from the peripheral part of the vitreous, particularly near the equator. They are more difficult to see in preparations from the posterior surface or from the central core of the vitreous body. However, preparations made by cutting out small pieces of vitreous from these regions and allowing them to drain to about one third their original size contain typical fine fibres. They appear to be more concentrated at the periphery than in the vitreous core.

Friedenwald and Stiehler (1935) showed that, if cattle vitreous bodies are cut into outer and inner fragments, an insoluble material is contained in and can be recovered from all parts. The vitreous is thus not simply a homogeneous jelly encased in a membranous bag; it has an internal structure as well. This has been confirmed by cutting a frozen eye so that the vitreous was separated into front, back, side, and centre pieces. The fragments were weighed and then washed by suspension in distilled water for several days to remove salts and other soluble constituents. They were then dried and re-weighed, and the weight of insoluble residue/100 g. fresh vitreous calculated. The back and the side pieces were combined as it would have been impossible to weigh each separately. The weight of residue from each area was : vitreous front, 21.3 mg./100 g. ; vitreous back and sides, 17.3 mg./100 g.; vitreous centre, 12.7 mg./100 g. These figures show that the centre of the vitreous contains about half as much insoluble material as the periphery.

Hyaline Membrane.—In many preparations made from the surface of the vitreous body small pieces of an optically homogeneous hyaline membrane can be found, looking very like a piece of crumpled cellophane (Fig. 3). Preparations of this membrane can be made more readily from eyes which have remained

overnight in the refrigerator than from absolutely fresh eyes. This suggests that in the fresh eye the membrane is more firmly attached to the retina and is thus difficult to detach from it. However, since preparations of membrane have been made from completely fresh eyes, particularly by dissection under saline, there is little doubt that the membrane is present *in vivo* and is not an artefact. When the point of a knife is gently pushed through the surface of a fresh cattle vitreous and then withdrawn, the vitreous herniates through the puncture. This seems to show that the surface is bounded by a membrane of some kind. As the hyaline membrane can be prepared from entirely fresh vitreous it seems logical to consider that herniation occurs owing to puncture of a membrane.

Effect of Collagenase and Trypsin on Vitreous Structures.—Pirie and others (1948) have shown that collagenase preparations from *Cl. welchii* liquefy the ox vitreous body, but that trypsin does not do so. The effect of preparations of these two enzymes on the microscopic structure of the ox vitreous body has therefore been examined.

Addition of either enzyme to preparations mounted on microscope slides gave unsatisfactory results. The enzymes were slow to act, perhaps owing to their slow rate of penetration into the vitreous gel, and the preparations dried during overnight incubation. Strips of vitreous body taken from the required position were therefore immersed in enzyme solutions with the addition of one drop of chloroform, and the mixture incubated in small stoppered bottles at 37°. Control strips were incubated in saline. Hyaluronidase, prepared from rabbit testis, was added to both control and test preparations to accelerate the rate of penetration by breakdown of the vitreous hyaluronic acid. Preparations were usually examined after incubation overnight. The gross appearance was noted and if there was a tangible residue it was examined microscopically. The enzymes affect the structures in different ways. Trypsin digests the coarse branching fibres and the hyaline membrane but not the fine fibres, wheras collagenase digests the fine fibres and the hyaline membrane, but not the coarse branching fibres. Both collagenase and trypsin preparations probably contain other enzymes and it could be argued that it is these unknown enzymes that are effective. There is no evidence for this and it seems more reasonable to assume that it is the main enzyme of the preparation that digests the fibres.

TABLE I

EFFECT OF ENZYMES ON VITREOUS STRUCTURE OF OXEN

Type of Structure	*Coarse Branching Fibres*	*Membrane*	*Fine Fibres*
Trypsin	digested	digested	not changed
Collagenase	not changed	digested	digested

These results, together with the fact that collagenase liquefies the vitreous (Pirie and others, 1948), suggest that the fine parallel fibres are the main structural element in the vitreous mass. In the earlier work great care was taken to free the vitreous body from the pigmented processes at its base and it is probable that most of that region of vitreous containing the coarse branching fibres was removed with the pigmented processes. If the entire vitreous body, including the ring of pigmented processes, is injected with collagenase and digestion is allowed to proceed to completion, the mass of vitreous is liquefied but there remains a thin ring of pigmented processes. This residue seen under phase-contrast shows only the coarse branching fibres. It therefore seems likely that these fibres originate in the ciliary region and pass only a short way into the vitreous mass.

If a complete vitreous body is treated with trypsin the mass remains intact, but the pigmented ring at the base is dissolved and the fluid surrounding the vitreous becomes full of pigment granules. This confirms the smaller scale experiments which showed that trypsin digests the coarse branching fibres.

PIGEON VITREOUS BODY.—The dissection and examination of the pigeon vitreous body was made in the manner previously described. The structures found differed from those of oxen in two ways. No coarse branching fibres could be seen and the material making up the mass of the vitreous showed a granular appearance and it was difficult to decide whether true fibres were present. Figs 6 and 7 show preparations from the equatorial region of the pigeon vitreous. Preparations showing the hyaline membrane could easily be made and Fig. 8 shows the typical appearance. Pigeon vitreous body is firmly attached to the ciliary processes and microscopic preparations made from this region, which show no coarse branching fibres, contain sheets of the hyaline membrane. Attachment of the vitreous body may be made through this. Enzyme digestion of pigeon vitreous body showed that it is almost completely digested by collagenase. The residue consists of fragments of the ring of pigmented ciliary processes held together by sheets of cells. Trypsin did not liquefy the vitreous mass but digested the hyaline membrane. Preparations were examined, after digestion, both with the naked eye and microscopically.

MONKEY VITREOUS BODY.—The monkey eye showed an interesting difference from those of the ox and pigeon in that it was extremely difficult to separate the vitreous body from the retina. This was so whether or not the eye was dissected under saline. If a "window" was made in the sclera and the choroid was then removed leaving the retina in position it was almost impossible to brush or scrape off the retina without injury to the vitreous. In the other animals examined the retina can be peeled off the vitreous quite easily even immediately after death. The vitreous was less viscous than that of cattle and pigeon and a cut through its surface usually caused semi-fluid jelly to escape.

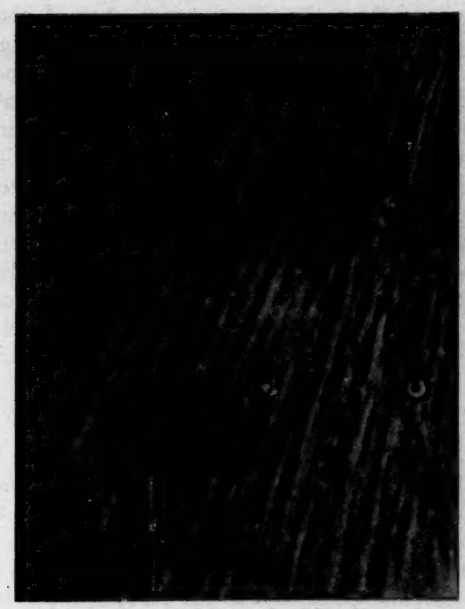
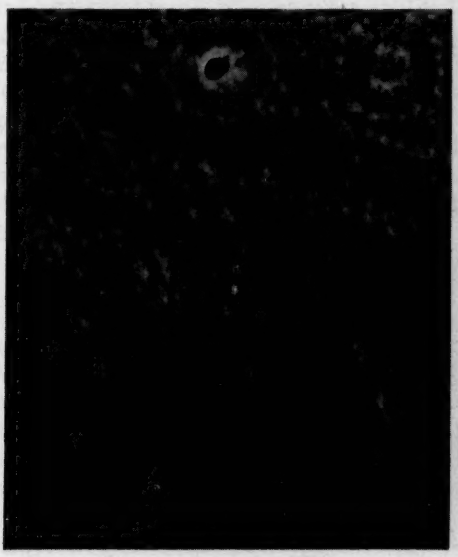


FIG. 5.—Ox, parallel strands of fine fibres of vitreous mass.

FIG. 8.—Pigeon, hyaline membrane of vitreous surface.



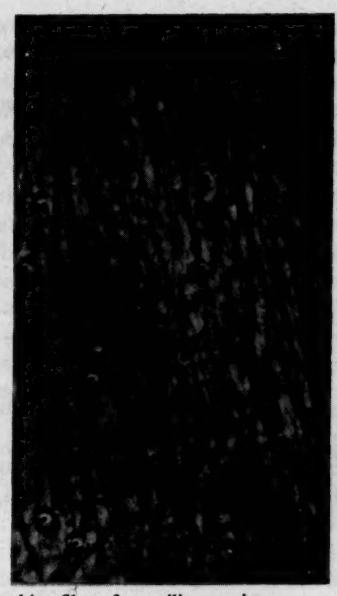
FIGS 6 and 7.—Pigeon, granular material of vitreous mass.

Preparations of monkey vitreous from the ciliary region showed coarse fibres attached to the ciliary processes, very similar to those of cattle (Figs 9 and 10). Preparations made from the other parts of the vitreous body showed very fine parallel fibres. Fig. 11 shows two layers of these criss-crossing and Fig. 12 a more granular type of fibre reminiscent of those seen in the pigeon. In no preparation were we able to see a hyaline membrane. This may be because our method of dissection is unsuitable, the membrane being left attached to the retina. More drastic treatment might reveal it, but since only a limited number of eyes were available, it seemed better to repeat exactly the techniques used with other animals in order to make a direct comparison. A single experiment to find the effect of enzymes on monkey vitreous showed that the coarse fibres were digested by trypsin, but not by collagenase, and the fine fibres of the vitreous mass by collagenase but not by trypsin.

Discussion

The question arises whether the microscopic appearances reported in this study are artefacts. There is considerable evidence, derived from slit-lamp examination of the vitreous during life and from work with animal eyes, that the vitreous has an organized structure. The vitreous bodies used in our experiments have in most cases been examined within one hour of death and it seems improbable therefore that the appearance of the fibres is due to *post-mortem* changes. Moreover, they remain stable over long periods. They are found in eyes as different as those of ox, pigeon, and monkey, and this also is in favour of the view that they are present *in vivo*, for artefacts might be expected to be more diverse. Collagen from rat tail tendon, but not most other sources, can be taken into solution in weak acid and reprecipitated as fibres at neutrality or by addition of salts (Nageotte, 1927). We do not think it can be argued that any such precipitation of soluble collagen as fibres takes place between enucleation of the eye and examination of the vitreous microscopically. The *p*H and salt concentration of the normal vitreous are such that any collagen present will be insoluble *in vivo*. Friedenwald and Stiehler (1935), studying the vitreous with the ultramicroscope, concluded that it consists of sheets laid down parallel to the surface. They were satisfied that the sheets were not optical artefacts.

Schwarz and Schuchardt (1950), using phase-contrast and dark-ground illumination, found fibres in the ciliary region that can be identified with the coarse branching fibres we have found. They also described a network of finer fibres in the body of the vitreous and immediately behind the lens. We have not seen any network structure except in vitreous which had previously been frozen at - 40°F. The difference may be due to difference in method of examination since we have used a magnification of × 600 whereas Schwarz and Schuchardt, judging from their photographs, used magnifications of × 70 to × 100. With this magnification it would be difficult to detect the fine parallel fibre pattern.



FIGS 9 and 10.—Monkey, coarse branching fibres from ciliary region.

FIG. 11.—Monkey, fine fibres of vitreous mass; two levels criss-crossing.

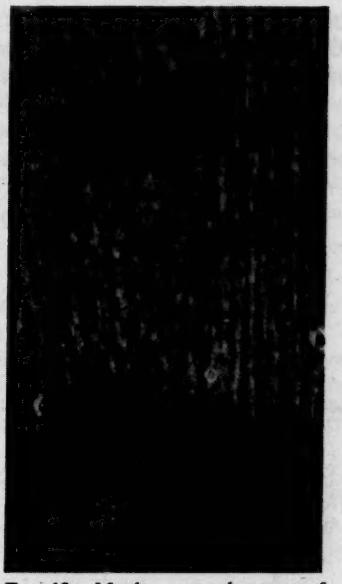


FIG. 12.—Monkey, granular type of fine fibres of vitreous mass.

The adult vitreous body has usually been considered as uniform in structure, except by embryologists who have described its multiple origin. Examination by phase-contrast microscopy combined with enzyme analysis has shown that it is both morphologically and chemically complex. The insoluble protein of the main vitreous mass reacts like collagen to enzymes, but the vitreous body at the ciliary region contains another fibrous protein resistant to collagenase. The hyaline membrane again differs in its digestibility by enzymes and in its structure from both types of fibre. These results are of some interest in any consideration of pathological changes in the vitreous, where one or other of these different constituents may be involved.

It remains to discuss the relation between the microscopical findings, the embryological origin of the vitreous and the appearances seen in the human vitreous on slit-lamp examination.

Correlation with Embryological Origin of Vitreous Body.—Which cell layers contribute to the structure of the vitreous body is still uncertain. Mann (1949) considers that the adult human vitreous is practically entirely derived from the neural ectoderm, whereas Dejean and Granel (1947) deduce that the vitreous structure is largely mesodermal, as it stains histologically in the same way as collagen. Reconciliation of these two views can be achieved if the neural ectoderm is thought capable of producing a protein somewhat like the typical mesodermal protein collagen, or if we accept the view of Polyak (1941) that some of the glial cells of the retina are mesodermal and that these form vitreous fibrils. The structure of the vitreous body, as indicated by phase-contrast microscopy and chemical analysis, may then be correlated with that described by embryologists (Table II).

TABLE II

Type of Structure	*Coarse Branching Fibres*	*Fine Parallel Fibres*	*Hyaline Membrane*
Position	ciliary region only	vitreous mass	vitreous surface
Enzyme Digestion	trypsin digests; collagenase has no effect	trypsin has no effect; collagenase liquefies	digested by collagenase and trypsin
Suggested Cell Origin	neuroectoderm	glial cells of retina or neuroectoderm	—
Position in Mann's Scheme of Vitreous Development	tertiary vitreous fibres	secondary vitreous fibres formed from inner layer of optic cup by outgrowth of sustentacular fibres of Müller	—

The supposition that neuroectoderm can produce a collagen protein gains support from a consideration of the vitreous of the bird which has very little mesoderm in its origin (Mann, 1949). Phase-contrast examination shows that the mass of the bird's vitreous is made up of material which is more granular than, but is reminiscent of, the fine parallel fibres of the mammalian vitreous and this material is liquefied by collagenase. It must therefore be concluded that some non-mesodermal cells have produced a protein that reacts to enzymes in the same way as the mesodermal protein collagen. Or we may designate some retinal glial cells as mesodermal (Polyak, 1941) and assign to these the formation of vitreous fibrils.

The evidence derived from phase-contrast microscopy and enzyme digestibility does not help to decide the origin of the hyaline membrane bounding the vitreous. Mann (1949) considers that the internal limiting membrane is formed from the foot plates of the fibres of Müller, but as this membrane stains differently from Müller's fibres, Wolff (1948) considers that this cannot be so. The fact that the hyaline membrane seems to be digested by both trypsin and collagenase suggests that it is different from the vitreous fibres and similar to the lens capsule which reacts to these enzymes in the same way (Pirie, 1951).

Correlation with Slit-Lamp Appearances.—Illustrations in the slit-lamp atlases of Vogt (1941) and Berliner (1949) show many different appearances in the pathological vitreous. The normal vitreous is less full of incident but observers agree that it is not optically empty. A wavy curtain-like structure is seen behind the lens, and filmy membranes deeper within the vitreous body have been described. Preparations of ox vitreous taken from immediately behind the lens show nothing except the fine fibres of the main vitreous mass. It is possible that in the human eye the curtain-like appearance is given by the anterior vitreous boundary whether there is an extra membrane present or not.

The filmy membranes seen in the deeper parts of the vitreous body may be related to the fine fibres seen in phase-contrast preparations.

The pathological vitreous may show three main differences from the normal :

(1) there may be knotted-up shreds of fibres and membranes;
(2) there may be shrinkage of vitreous to give a boundary line within the eye between the shrunken vitreous lying in the bottom of the eye and an optically empty space above;
(3) there may be the appearance of vitreous detachment with a hole in the membrane on the back face.

The first two appearances can be accounted for in terms of the microscopical appearances seen with phase-contrast ; the third needs more attention. It is possible that the same appearance could be given by detachment of the vitreous, leaving the internal limiting membrane attached to the retina, or by detachment of vitreous together with the internal limiting membrane. A decision on this point would be very interesting as it seems

to have a bearing on the relation between vitreous detachment and detachment of the retina.

The results given in this paper are preliminary only. In particular, the spatial relation between the three structures described—coarse branching fibres, fine fibres, and hyaline membrane—needs further study. The front limit of the hyaline membrane has not been defined in any eye and the adherence of the retina to the vitreous body in the monkey has to be examined. The earlier results of Schwarz and Schuchardt (1950) demonstrated the value of phase-contrast microscopy in the examination of the eye. The present study shows that such microscopy, combined with enzyme analysis, can help to characterize the various structures of the vitreous body.

Summary

(1) Examination of the fresh vitreous body of ox, pigeon, and monkey by phase-contrast microscopy shows that the vitreous of these animals has a complex structure of fibres and membrane.

(2) The effect of the enzymes collagenase and trypsin on these structures is described and it is concluded that they are chemically different.

(3) The relationship of the microscopic appearances to the embryological origin and slit-lamp appearances of the vitreous is discussed.

We have pleasure in acknowledging gifts of collagenase preparations from Dr. R. O. Thomson of the Wellcome Research Laboratories, and also wish to thank the staff of the Oxford and District Co-operative Slaughterhouse for their help in obtaining fresh ox eyes.

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NERVOUS MANIFESTATIONS IN EALES'S DISEASE*

BY

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IN 1880 and again in 1882 Henry Eales of Birmingham described the clinical picture of primary recurrent retinal haemorrhage in young adults. His seven cases were all young men, whose ages ranged from 14 to 29. They had in common a history of headache, epistaxis, variations in peripheral circulation, dyspepsia, and chronic constipation. One was diagnosed as having mitral incompetence, and in two the urine contained the slightest trace of albumen, but otherwise they bore no stigmata of bodily disease. Eales regarded the condition as a very rare one, and believed it to be a vaso-motor neurosis which, by causing constriction of alimentary vessels and compensatory dilatation of those of the head, led to rupture of retinal and nasal vessels and consequent haemorrhage.

Eales's disease is now a well-recognized entity, though it is agreed to be rare. Characteristically its age of onset is between 15 and 40 years, affecting both sexes, but with a preponderance in males. In most cases both eyes are ultimately attacked, though symptoms may be unilateral for some while. The retinal haemorrhages are very frequently accompanied by bleeding into the vitreous body, and it is the latter occurrence which most often drives the patient to seek medical advice. The ophthalmoscopic picture ranges from one of obstruction of the central retinal vein with multiple haemorrhages and generalized venous distension to one of variation in calibre and local sheathing of a single vessel, often peripherally situated. The vitreous may be faintly hazy or so clouded with blood as to make the fundus invisible. At a later stage retinitis proliferans and permanent vitreous opacities may be found. The course of the disorder is unpredictable but generally unfavourable.

Many suggestions have been made as to its aetiology. Up to now there have been two main theories current, neither of which commands unqualified support: the first that it is a manifestation of tuberculosis, and the second that it is a localized and early stage of Buerger's disease. The idea that it is a tuberculous affection of the retinal vessels seems to have grown up about the turn of the 20th century (Simon, 1896; Noll, 1909; Axenfeld and Stock, 1911; Fleischer, 1914). It was based partly on evidence gained from the examination of eyes removed for secondary glaucoma, and partly

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on the demonstration of tuberculosis elsewhere in the body. It has been supported latterly by various writers, amongst them Safar (1928), Gilbert (1935), von Hippel (1935), Suganuma (1937), Verhoeff and Simpson (1940), and Schmid (1945), but other ophthalmologists have contested this opinion on the grounds that in the majority of cases no history or signs of Koch's infection are present (Moore, 1925; Hutchinson, 1932; Ballantyne and Michaelson, 1937; Paton, 1938; Benedict and Wagener, 1940; O'Malley, 1943).

Its ascription to thromboangiitis obliterans of the retinal vasculature is a relatively recent development. Marchesani (1934, 1935) first put forward this conception on clinical and histological grounds, and since then (according to Benedict and Wagener) several other authors have reported agreement with his conclusions (for example, Ludwig, 1935; Mikuni, 1936; Uyama, 1936). Whilst there is no doubt that thromboangiitis obliterans may occasionally affect the retinal vessels (Gresser, 1932; Birnbaum and others, 1934), it seems likely that it seldom or never gives rise to the picture of recurrent intra-ocular haemorrhage as described by Eales. Schmelzer (1937) examined six cases of thromboangiitis obliterans, and though one had had closure of the central retinal artery some years before, none had symptoms or signs of vitreous bleeding. In a recent article, Schmid (1945) has published observations of 85 patients with typical Buerger's disease. In none was there history of ocular disturbance, and objective ophthalmological abnormality was present in only sixteen; in the majority it consisted simply in narrowing of the retinal arteries or alternatively of venous dilatation, and in a few there was mild macular degeneration. Conversely, in 25 patients with Eales's disease, he found not the least suspicion, either symptomatically or from careful physical examination, of thromboangiitis obliterans of the limb vessels. Schmid was unable to accept the vague symptoms of peripheral vascular disorder, of which some of Marchesani's patients complained, as of critical significance, and expressed the conviction that Marchesani's claim could not be substantiated from clinical evidence. Hager (1949) had written in similar vein; study of the case-records of 95 patients with Eales's disease proved that none had had symptoms or signs of peripheral thromboangiitis obliterans, and he argues that there are, in any case, notable differences between the two conditions, even when, as occasionally happens, the latter presents ocular manifestations.

Critical studies of the histology of the retinal lesions in Eales's disease cast considerable doubt on the correctness of both the tuberculous and the thromboangiitic interpretations of its pathogenesis (Ballantyne and Michaelson, 1937, 1947; Loewenstein and others, 1946). According to these authors, the lesions consist essentially in a patchy cellular infiltration, which at its outset is within the substance of the walls of blood vessels. The vessels attacked are predominantly but not exclusively veins, arteries

and capillaries occasionally being affected likewise; the small veins at the periphery of the retina are often those affected earliest. The character of the cellular accumulation is chiefly lymphocytic, but there may be, additionally or alternatively, a proliferation of endothelial cells; giant cells are lacking. Beading and dilatation of the veins from stasis of blood flow is a prominent microscopical feature, with overfilling of the capillary bed, and there is not uncommonly venous thrombus formation. The retinal and vitreous haemorrhages characteristic of the malady arise from rupture of vessel walls at points weakened by disease, where micro-aneurysms may develop. Signs of vascular pathology are not limited to the fundus oculi, but may be seen also in the optic nerve and its sheath (Safar, 1928; Verhoeff and Simpson, 1940; Loewenstein and others, 1946). In summary, the histological findings are those of an inflammatory reaction; though they might at a pinch be held consistent with tubercle or with thromboangiitis obliterans they are by no means typical or frankly diagnostic of either state.

Loewenstein and his colleagues (1946) propose "retinal vasculitis" as the most accurate descriptive term for Eales's disease, since it conveys briefly the nature of the underlying pathology. It has also been suggested (Ballantyne and Michaelson, 1937) that this vasculitis may not be an expression of a single disease, but rather a phenomenon common to several, which are themselves of different aetiology. Benedict and Wagener (1940) are of similar opinion, holding that the lesion of the vessel walls is in all probability a non-specific one. Recently O'Malley (1944) has advanced the hypothesis that Eales's disease is an allergic syndrome, a retinal endophlebitis which may be set in motion by any one of a number of allergens. The histology of the lesions is quite in accord with such an interpretation, and the observations of Uyama (1936) may be taken to lend it some support from the experimental point of view. This writer was able to induce retinal venous lesions in four out of 26 rabbits by the injection of living tubercle bacilli into the blood-stream, after preliminary sensitization with tuberculous antigens.

Neurological complications of variegated pattern, pointing to mischief in either cerebral hemisphere or spinal cord, have been reported from time to time in Eales's disease (Ballantyne, 1909; Loewenstein, 1931; Marchesani and Stauder, 1935; Ballantyne and Michaelson, 1937; Silfverskiöld, 1947; Veirs, 1948). Through the courtesy of our ophthalmological colleagues at the Birmingham and Midland Eye Hospital we have lately had the opportunity of examining six patients suffering from recurrent intra-ocular haemorrhages, with a view to discovering whether they presented symptoms or signs of nervous ailment.

Case Reports

Case 1, Raymond M, aged 25, industrial chemist. Nothing of note in previous medical or family history.

In mid-July, 1950, discovered one morning when dressing that sight in right eye was

defective, "as though muddy water had been splashed in it". Came under the care of Mr. Douglas, who diagnosed Eales's disease. Treated by local *x* radiation (4,000r) of affected eye. No recurrence of intra-ocular bleeding. Only complaint now is that in bright sunlight he is aware of a peaked shadow in front of right eye.

Examination (*May 16, 1951*).

Right eye: well-marked retinitis proliferans extending from upper temporal margin of disk out into vitreous, and some small patches of choroido-retinal degeneration in lower temporal periphery of fundus. Vessels appear normal. Visual acuity J1 and 6/6.

Left eye: media clear, fundus normal, visual acuity J1 and 6/6.

No neurological signs. Heart normal. Blood pressure 125/80. Limb pulses all normal, no obvious abnormality of skin colour or temperature. Liver edge palpable 1-2 fingers on deep inspiration, and tender. Some small glands both axillæ.

Case 2, Leslie N, aged 31, gardener. Previous medical and family history not relevant.

In September, 1944, whilst serving with the army in Belgium, suddenly became aware of dark patches in front of right eye, and a week later lost the sight completely in this eye. Vision gradually recovered, but 2 months later again failed suddenly, to recover more slowly. Had further severe attacks in 1946 and 1949, both in the right eye. Came under the care of Mr. Jameson Evans in August, 1950, who made a diagnosis of Eales's disease and treated him with *x* ray (2,800r) to right eye.

At various times in the last 5 years he has had slight similar trouble with the left eye, but has never had a haemorrhage severe enough to worry him. For the same period has been subject to recurrent right frontal and retro-orbital headache. No other complaints.

Examination (*May 21, 1951*).

Right eye: visual acuity light perception only. Massive vitreous opacity which completely obscures fundus.

Left eye: visual acuity J1 and 6/6. No abnormality of media or fundus.

Heart healthy. Blood pressure 135/85. Peripheral pulses full, no alteration of skin temperature or colour apparent. No neurological signs. General examination negative.

Case 3, Nora F, aged 18. In Blind Institute from age 6 because of severe congenital myopia. Previous medical history otherwise irrelevant, and family history non-contributory.

In July, 1949, sight in left eye rapidly fogged over till she could see nothing but a white mist. She gradually recovered but a few weeks later, when lifting something heavy, her sight suddenly failed again. In October, 1949, Mr. Jameson Evans, having diagnosed Eales's disease, treated her with local *x* radiation (4,000r). A month or two later, the day after a fall, she woke to find that the sight had once more failed in the left eye; there has been no improvement since this time. In the last 18 months, sight in right eye has also worsened. Since July, 1949, she has complained of recurrent frontal headaches of throbbing character, brought on by stooping, heat, or exertion. No other symptoms.

Examination (*May 22, 1951*).

Left eye: perception of light only. Grey opacity throughout vitreous, which altogether obscures fundus.

Right eye: can just count fingers. There is a dark opacity in temporal half of vitreous, which masks part of fundus, and rest cannot be clearly distinguished because of very high grade myopia. The eyes are in constant wandering motion.

No neurological signs. Heart normal. Blood pressure 145/80. Peripheral pulses normal. General examination negative.

Case 4, Albert R, aged 28, furnaceman. Family history irrelevant, Previous medical history: occasional lumbago and left-sided sciatica for 2 years. Had right-sided epididymectomy in July, 1950, for low-grade chronic non-tuberculous infection of 12 months' duration.

Three years ago suddenly discovered sight in left eye defective, as if there were a grey smoke in front of it. Seen by Mr. Jameson Evans, who diagnosed Eales's disease, and later recommended *x* ray treatment, which was given in August, 1949 (4,000r). Sight recovered satisfactorily. No recurrence of haemorrhage in left eye, and never any trouble with right. No symptoms referable to other systems.

Examination (*May 30, 1951*).

Both eyes: no abnormality now detectable. Visual acuity J1 and 6/6 in the right eye; J4 and 6/12 in the left eye.

Heart normal. Blood pressure 145/80. Peripheral arteries healthy. No neurological signs. Slight restriction of forward flexion of lumbar spine, and of straight-leg raising on left. No other abnormal physical signs. .401

Case 5, Nugent McT, aged 28, stove assembler. Nothing relevant in previous medical or family history.

In October, 1947, first noticed something wrong with left eye, like a film over the sight. In April, 1948, vision in this eye suddenly failed. Seen by Mr. Weeden Butler, who diagnosed Eales's disease and treated him with deep *x* ray (4,000r). There has been no recovery of visual acuity in left eye. In last 3 years he has had occasional slight transitory disturbances of sight in right eye. No other symptoms at all.

Examination (*June 13, 1951*).

Left eye: perception of light only; complete vitreous opacity.

Right eye: media clear. No retinal haemorrhage or degenerative change. Arteries show some variation of calibre, and veins are a little swollen and constricted at arteriovenous crossings. Visual acuity 6/18 and J4.

Heart normal. Blood pressure raised (165/100). Peripheral vessels healthy, no skin colour or temperature change apparent in extremities. No neurological signs. Other systems negative.

Case 6, Edith S, aged 27, married. History of recurrent bilious attacks as a child, and of "growing pains" without joint swelling or recognized fever, with breathlessness on exertion from the age of 14 or 15. Between ages of 17 and 21 had occasional migraine, ushered in by dazzling flashes in front of eyes and gradually developing constriction of visual fields, followed by frontal and retro-orbital headache lasting several hours, with nausea and vomiting. Family history non-contributory.

In 1946 she first developed symptoms of intra-ocular bleeding in the right eye, and some months later, the left was also affected. She was seen by Mr. Jameson Evans who diagnosed Eales's disease. The right eye was treated with *x* rays (4,000r) in November, 1947, and the left eye (1,500r) in October, 1948. She has had several recurrences of haemorrhage in each eye since the radiation, but the sight has recovered fairly quickly and completely in each instance.

Examination (*June 20, 1951*).

Right eye: dark opacity in vitreous inferiorly and anteriorly. Fundal vessels and retina appear normal. Visual acuity J1 and 6/6.

Left eye: slight diffuse vitreous haze from recent haemorrhage, which interferes with detailed examination of fundus, but no gross abnormality present. Visual acuity J4 and 6/18.

Heart enlarged to left with mitral diastolic murmur; there is auricular fibrillation with a large pulse deficit. Blood pressure 140/90. Exercise tolerance poor. Limb vessels healthy, no peripheral colour change or temperature abnormality. No neurological signs. No other physical abnormalities.

Conclusions

In the six patients examined by us, the duration of whose ophthalmic symptoms ranged from 10 months to 6½ years, we discovered no manifest

evidence of nervous disease, a finding in conformity with the larger experience of Silfverskiöld (1947), who recorded the follow-up of 22 patients, diagnosed from 6 to 15 years earlier as suffering from Eales's disease. Headache was a symptom in three of our patients, but no other complaint of neurological bias was made spontaneously, or could be elicited by direct enquiry. In one patient (Case 6) the headache can confidently be dismissed as nosologically irrelevant to the ocular condition, since this was a woman who had suffered from paroxysmal vomiting since early childhood, which was replaced at the age of 17 by attacks of true migraine, a not unusual sequence of events to which Gowers (1907) drew attention many years ago. Her story is so typical that there is no good reason to believe that it is indicative of actual disease of the cephalic vessels; it is now generally accepted that the phenomena of migraine occur upon a physiological background of vasomotor instability in the carotid system. In the other two patients (Cases 2 and 3), where headache developed after the onset of eye trouble, the clinical evidence on which to base a decision is less clear-cut. Although it seems unlikely to us that there was spread of vascular pathology to the cerebral vessels, it is a possibility which cannot be absolutely denied without histological check.

With reference to the neurological complications of Eales's disease which have been reported in the literature, a word of caution about their too ready acceptance must be entered. It appears open to question how far any have really been the result of vasculitis of cerebral or spinal vessels comparable with that seen in the retina. Histological proof of characteristic lesions in the eye and of the presence of vascular lesions in the nervous system, with establishment of their essential identity, is a prime necessity. In the absence of such proof, so-called complications may in fact represent no more than the chance association of two aetiologically remote illnesses. Indeed it is our conviction that, to date, all the published cases with coincident neurological symptomatology either belong in such a category or else are not examples of Eales's disease at all. So far as we can discover, amongst reported cases with neurological disorder, *post-mortem* investigation of the nervous system has only been undertaken once, namely in Case 5 in the series described by Marchesani and Stauder (1935). This was a man of 45, who had no ocular symptoms other than occasional bright specks in front of his eyes, chiefly when reading. Four or five months before admission to hospital, he developed progressive weakness of his right arm and later of his right leg, together with headache and difficulty in finding his words. On examination he presented a mild dysphasia with right-sided pyramidal signs and sensory disturbance of cortical type. The fundi showed sheathing of arteries and veins on the surface of the disks, extending a short distance on to the surrounding retina, but the eyes were otherwise normal. He was suspected of harbouring a cerebral tumour, or (in view of certain peripheral vascular symptoms and signs) possibly of having cerebral Buerger's disease. He

shortly died of an intercurrent pneumonia, and at autopsy was proved to have thromboangiitis obliterans of the cerebral vasculature. The existence of cranial Buerger's disease has been recognized as an entity for nearly 20 years, since the pioneer studies of Foerster and Guttmann (1933), and there need be no hesitation in accepting the case as an example of that malady. However, reasons have already been given for doubting the validity of Marchesani's identification of Eales's disease as a localized form of thromboangiitis obliterans. We should be more than reluctant, therefore, to regard the case as an example of true retinal vasculitis with complicating neurological features.

Finally we should add that, in the cases under review, no symptoms suspicious of Buerger's disease could be unearthed in the anamnesis; pulsation was readily demonstrable in the peripheral vessels of both arms and legs in all cases, there was no trace of gangrene or cyanosis of the extremities, and skin temperatures (as judged simply by touch) were not in any way disturbed.

SUMMARY

(1) The history of Eales's disease is traced, and its symptomatology and pathology described. Neurological syndromes, indicative of cerebral or spinal dysfunction, have from time to time been asserted to appear as complications.

(2) Six cases of Eales's disease have been examined for signs or symptoms of nervous disorder, with negative results.

(3) It is pointed out that in cases of Eales's disease presenting a neurological semeiology, the latter can only be accepted as a complication in the strict sense, if backed by evidence of vascular lesions in the central nervous system histologically identical with those found in the retina. It appears that no case satisfying this criterion has yet been reported. In the absence of such pathological control, nervous disorders may be mistakenly regarded as complications, when in fact they represent a fortuitous superimposition of a second malady upon the original one. It seems likely that most of the published cases, with neurological signs purporting to be complications, are to be looked upon as examples of such a chance association of two diseases. In others, the primary diagnosis of Eales's disease is inadmissible; thus in one recorded case with autopsy findings, the ocular and nervous signs were due to thromboangiitis obliterans of retina and brain respectively.

(4) No symptoms or signs suggestive of Buerger's disease were noted in the cases under review.

We must acknowledge our indebtedness to Mr. Charles Rudd, Mr. R. D. Weeden Butler, Mr. P. Jameson Evans, and Mr. A. A. Douglas, for permission to publish observations relating to cases under their care.

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CASE NOTE

ORBITAL ENCEPHALOCELE ASSOCIATED WITH ACROCEPHALY*

BY

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ORBITAL encephalocele is a congenital tumour, which is supposed, according to its definition, to be in communication with the intracranial cavity. Its existence suggests the presence of a defect in the bones of the orbit. The theories which pretend to explain the pathogenesis of this anomaly are based on two principal ideas:

(*a*) an ossification anomaly of the skull is the primary factor of the encephalocele;

(*b*) an hydropic cyst of the cornu ventriculi, with or without added glial proliferation, is formed first, and the bone defect of the skull results from its occupation by the cyst.

Our case seems to corroborate the first idea.

Though there is a great diversity of opinion on this subject, most authors agree that the coexistence of other anomalies of the skull with those of the eye is almost constant. Our case presents two peculiarities: first, the encephalocele had been mistaken for an angioma of the orbit and its diagnosis was ascertained only by the help of various laboratory and radiological examinations; secondly, it was associated with an oxycephaly, the only symptom of which was the characteristic aspect of the skull.

Case Report

M. C., a young man, aged 25, was sent to us by a military doctor from a recruiting office. The patient had never complained of a small tumour at the right of the root of the nose nor of a bigger one occupying the inner part of the left orbit (Figs 1 and 2, overleaf). The medical history revealed little information about the development of these two tumours; according to the patient they had always remained the same size.

The small tumour at the right of the root of the nose, 2 cm. across, had pushed the right eyeball towards the infero-external angle of the orbit without producing a direct exophthalmos. A large vein ran vertically under the skin, on the inner side of this tumour, which was of soft consistency and was totally reducible. Palpation revealed a regular, oval, bony border, the inward part of which seemed to be formed by a prolongation of the spine of the frontal bone, ending near the dorsum nasi, so that a narrow gap was formed between the two. No fluctuation, pulsation, or thrill was noticed in this tumour. There were no pathological findings in the right eye.

* Received for publication October 24, 1951.

FIG. 1.—Front view of the two tumours.

FIG. 2.—Side view from the left.

The tumour on the left had pushed the left eyeball towards the external wall of the orbit. The ciliary portion of the eyelid border seemed shortened and the lacrimal portion considerably lengthened. The rima palpebrarum was narrower than normal. The puncta lacrimalia and the upper and lower fornices were quite normal. A conjunctival fold starting from the inner canthus covered the internal two-thirds of the cornea. The movements of the eyelids and eyeball were normal. The frontal apophysis of the left superior maxilla was more protuberant than that on the right, and this, in addition to the oblique direction of the dorsum nasi, gave to the face a typical asymetrical appearance. This tumour also was of soft consistency, but could be only partially reduced under pressure. Palpation revealed a regular, oval, bony border, the concavity of which was turned towards the root of the nose. When the patient, pressing his nose, made a forced expiration, the tumour in the right orbit showed a slight expansion, but the left showed no change. Irrigation of the lacrimal canals showed the left one to be obstructed.

Ophthalmoscopic examination revealed a narrowing of the arteries and the presence of a scleral crescent in the right fundus. Since the left cornea was almost totally covered with a conjunctival fold, only a small part of the peripheral retina could be seen, and this was found to be normal.

Vision in the right eye was 20/20; in the left counting fingers at 25 cm.

Wassermann, Mantoux, Casoni, and Weinberg reactions were negative. A puncture was made in the tumour of the left orbit, and 4 to 5 ml. of a transparent fluid, very similar to the cerebrospinal fluid, was obtained. Chemical and microscopical examinations of the fluid revealed the presence of sodium chloride and a few mononuclear cells, which confirmed our presumption that the tumour might be an encephalocele.

Radiological examination helped to corroborate this diagnosis by revealing the presence of a congenital bone defect in the region of the root of the nose. In the antero-posterior radiograph of the skull taken in the nose-forehead position, the bone defect had the shape of an apple (*Fig. 3*). The left ethmoidal cells seemed more enlarged than those on the right. The existence of the frontal sinuses could not be determined. The two spines of the frontal bone could be seen clearly. The radiographs taken in the optic foramen position showed that the bone defect was in the inner walls of the two orbits

(Figs 4 and 5). Ombrédanne (1947) presented a similar case with a bone defect in the same position.

The skull of our patient had the characteristic shape of a tower skull; it was very difficult to decide whether this was a case of ocular hypertelorism (Crouzon's disease): indeed there was no forward protrusion of the eyeballs, no atrophy of the optic nerves, no diminution of the vision, and none of the other secondary signs and

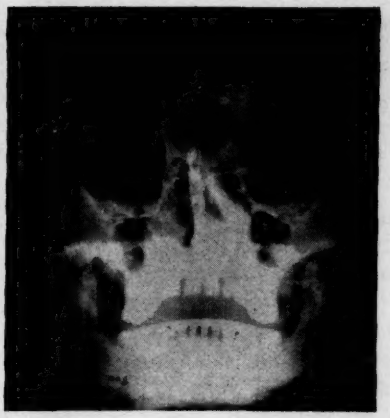

FIG. 3.—Antero-posterior radiograph of skull.

FIG. 4.—Radiograph of right optic foramen.

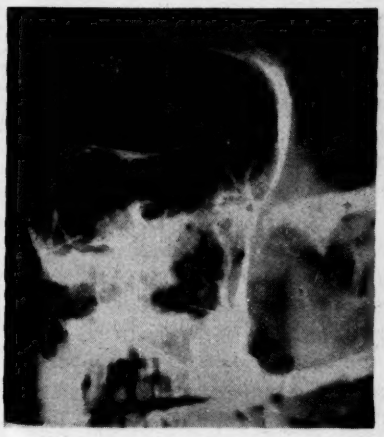

FIG. 5.—Radiograph of left optic foramen.

FIG. 6.—Radiograph of left sella turcica.

symptoms often encountered in this type of case. The optic foramina and the sella turcica were quite normal (Figs 4, 5, and 6). Only a slight degree of mental deficiency was

apparent such as is quite often seen in cases of encephalocele, and the tower skull was the only symptom.

The encephalocele may impede the manifestation of intracranial hypertension and explain the lack of symptoms. Crouzon's disease is attributed by many authors to an early ossification of the skull, and the coexistence of these two anomalies may suggest that an ossification anomaly was also a pathogenic factor in the development of the encephalocele.

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APPLIANCES

STEREO-CAMPIMETRY*

A METHOD FOR USE WITH THE BJERRUM SCREEN

BY

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FEW will deny the tedium of routine campimetry in any circumstances, and when the need for accuracy arises in a patient whose responses are vague and hesitating, the procedure is apt to be converted into one of competitive guesswork between the subject and the observer, the results of which are of somewhat uncertain clinical value. Unfortunately, it is in such cases that reliable information about the state of the visual fields is often of crucial value to diagnosis. The utility of the detection of small changes in the central fields in the early diagnosis of chiasmal lesions, for example, has been frequently noted in the literature. It is emphasized by Traquair (1942) in his description of the scotomatous type of field change seen in the chiasmal syndrome; and the significance of paracentral scotomata in the early stages of chiasmal pressure from pituitary tumours has been pointed out by Williamson-Noble (1939) and by Lyle (1939). The importance of small changes in the centro-caecal area in glaucoma is too familiar for comment.

Such considerations have prompted the present attempt to produce more reliable visual field records in these types of cases. One factor commonly giving rise to difficulty is that of fixation, which may be seriously hindered by the presence of central or paracentral scotomata, or because for some reason, organic or functional, the patient is unable to maintain concentration upon the fixation spot. The use of a binocular fixation device, which should attract fixation by a simple stereoscopic image, and enable a central defect to be plotted with greater certainty where present, suggested itself as a means towards this end.

The idea is not, of course, new. Schloesser (1901) advocated the use of binocular fixation by means of complementary colours viewed separately by the two eyes, and this method has recently been re-applied by Engel (1950). However, the known existence of wide individual variations in colour judgment, and of defects of colour vision in association with many central field defects suggested that a stereoscopic method such as is employed in the Lloyd stereo-campimeter might be preferable. Experience with this instrument however has shown that there were advantages in accuracy to be gained by adhering to the customary screen distance of 1 or 2 metres, in preference to the shorter working distance used in this instrument as at present made.

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The apparatus described by Fincham (1929) appeared to offer the required facilities, but as this was not to be bought trials were first made with this method, using an amblyoscope tube for fixation of the "covered" eye. Further modification has now resulted in the apparatus here described.

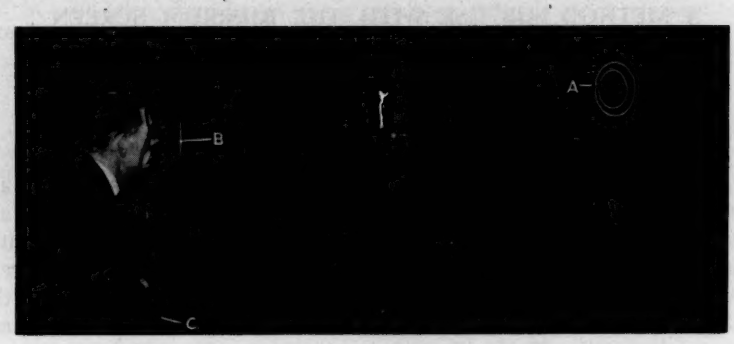

FIG. 1.—Apparatus in use, mounted on floor-stand headrest.

STEREO-FIXATION APPARATUS

The apparatus consists essentially of a stereoscopic pair of simple objects, one of which (Fig. 1, A) is fixed on to the ordinary Bjerrum screen and viewed by the eye to be examined, while the second is incorporated in a simple optical system (Fig. 1, B; 2, C; 3) and is viewed by the non-fixing eye. The objects used have been based on the synoptophore "bucket" slides, their relative sizes being so calculated as to give retinal images of similar size at the appropriate screen distance. Equality of illumination of the two objects is achieved by means of a rheostat (Fig. 1, C) regulating the illumination of the object seen by the non-fixing eye. This was the method employed by Fincham, and single binocular vision and a simple stereoscopic image are readily achieved by it.

The instrument has been used principally at a screen distance of 2 metres, but a hinge between the condenser tube (Fig. 2, B) and the viewing tube (Fig. 2, A) of the optical system gives access to this fixation object (Fig. 2, C), and enables it to be replaced by a larger one if examination at 1 metre is for any reason preferable. When the contralateral eye is to be examined, the whole tube is slid across into the appropriate position.

THE INSTRUMENT IN USE

This apparatus has been in regular use for a year or so at the Institute of Ophthalmology, the types of patient for which it has been employed being chiefly those with central or paracentral defects resulting from glaucoma. A few patients with purely central defects from macular lesions have also been examined.

The binocular image in general appears to provide an added stimulus to fixation, which assists in the accurate plotting of the field. Patients have stated that "It is less variable than without rings", "It is much easier, I concentrate better", or "The rings make me want to look in the centre". In a number of cases of doubtful defect in which the blind spot could not be plotted with monocular fixation it was reliably outlined with the binocular apparatus.

Since the inner ring of the bucket subtends a visual angle of approximately 5°,

the coarse stereopsis obtained is undisturbed by small central defects, and even when the field loss largely obliterates one image, binocular fixation appears to be retained with the remaining part of the object, if only as a form of simultaneous

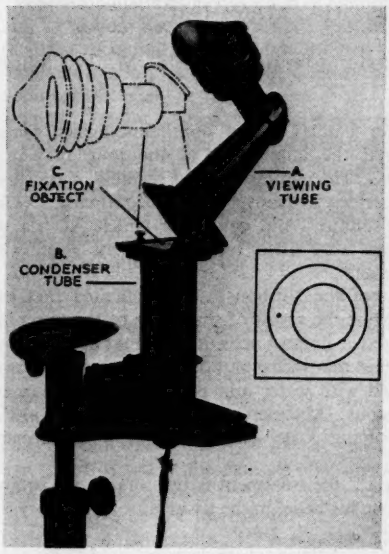

FIG. 2.—Apparatus hinged open for replacement of fixation slide (forehead bar of headrest removed).

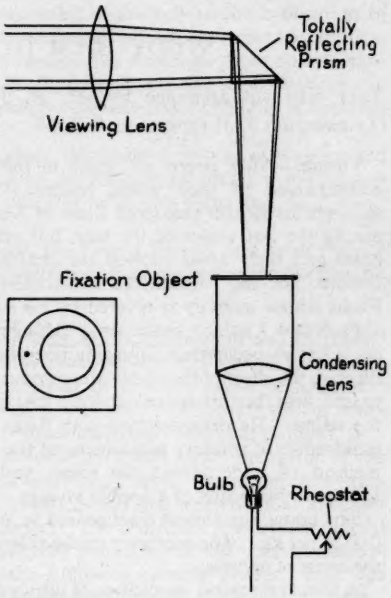

FIG. 3.—Optical system.

paramacular perception. The method is not invariably successful, and it does in an average case add to the length of time needed for an examination; but in doubtful cases, where a defect is suspected near a blind spot which cannot be outlined, or where the defect itself involves fixation, the field can usually be plotted with a certainty which is apparent both to observer and to patient.

I should like to express my appreciation for the help and encouragement which I have received from Sir Stewart Duke-Elder, and to thank the members of the staff of the Moorfields, Westminster and Central Eye Hospital who have allowed me to examine their patients. I am especially indebted to Mr. E. Fincham for the loan of his apparatus, to Mr. N. Roberts, in whose workshop at the Institute my apparatus was made, and to Miss E. J. Brown for her assistance in the examination of the patients and the collection of their records.

This research assisted by a grant from the Alexander Pigott Wernher Memorial Trust Fund.

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FACULTY OF OPHTHALMOLOGISTS

STUDY TOUR TO AUSTRIA, MAY, 1951

THIS visit was arranged by Mr. R. J. Buxton (*Yeovil*), and Mr. M. W. Smith (*Leamington Spa*) reports as follows :

Vienna.—After nearly 48 hours in the train a party of ten ophthalmologists, some accompanied by their wives, reached Vienna, the latter part of the journey being through the British Occupied Zone of Austria. The capital suffered severely, especially during the last weeks of the war, but great strides in recovery have been made. Our hosts and their wives showed the charm, hospitality, and gaiety for which Austria is famous. In the Allgemeines Krankenhaus we were often reminded of the Professor Fuchs whose memory is revered by his successors.

Professor Lindner spoke on " Detachment of the Vitreous " and indicated that he considers its occurrence following operation to be the result of shrinkage of the vitreous through the effect of the highly albuminous aqueous, not as Fuchs thought that the aqueous passed into the pre-retinal space ; that it never re-attaches but does not necessarily tear the retina. He demonstrated with flasks filled with water and gelatine the paramount importance of rotatory movements of the vitreous. Macular holes are treated by Guist's method of undermining the sclera and applying 3 per cent. peroxide of potassium 1/100 ml. by means of a special syringe.

Trachoma has almost disappeared in Austria ; the treatment is by sulfadiazine orally 0.03 g. per kg. The professor spoke at length on his belief in the tissue-autolysis theory as the cause of myopia.

A film and several operations of intra-capsular extraction were demonstrated. As with the other surgeons, he sits on the right side of the patient facing the head and makes the section with a Grieshaber knife. He employs a Mendoza suture, deprecates retrobulbar injection as causing haemorrhage, and relies on subconjunctival cocaine and Van Lindt's akinesia. Arruga's forceps are applied reversed to the upper pole and the lens is not tumbled. Mintacol is instilled and 20,000 units penicillin injected subconjunctivally.

On one occasion the Professor performed an annular scleral resection. The retina appeared to be re-attached with no improvement in vision. The widest resection has been 6 mm. Scleral incision is made with a calliper keratome and the full thickness removed, closure is by alternately facing mattress sutures, and the operation is completed by surface coagulation and diathermy punctures and keratotomy of the anterior chamber.

Professor Pillat spoke on " Hypertension and Atherosclerosis " and demonstrated a case of adolescent macular degeneration, the fourth seen that year after a negative period of 20 years. On a case of buphthalmos he demonstrated de Wecker's anterior sclerotomy combined with incision of the chamber angle by the method of de Vincentiis. Intra-capsular extractions were performed, using Liegard's suture of Japanese woman's hair, O'Brien's akinesia, retrobulbar injection, ung. eserine 1 per cent., and subconjunctival penicillin. Iridencleisis is favoured in chronic glaucoma, and if unsuccessful cyclodialysis, because of the heavy incidence of late infections with Elliot's trephine. A case of secondary glaucoma which had not responded to iridectomy and cyclodialysis was treated by Vogt's diathermic punctures.

At the Rudolfspital Professor Safar demonstrated intracapsular extractions, using O'Brien's akinesia and a parabulbar injection with Corbasil in place of adrenaline to obviate spasm of the central retinal artery. A complicated case of cataract with increased

tension, which had failed to respond to iridectomy and diathermic punctures, was treated by subscleral coagulation of the temporal long ciliary artery. Two cases were demonstrated, one a sarcoma of the iris and ciliary body treated by a flat cathode inserted subsclerally twice within 6 weeks with a good result, and the other a peripheral glioma which had not responded fully to radon seeds but responded adequately to the application of coagulation diathermy. A child of 6 months with bilateral glioma was treated by application of radium needles. We were fortunate to observe the Professor using Safar's nails in a case of retinal detachment combined with needle coagulation and scleral desiccation. The nails are only used in pre-equatorial cases owing to the technical difficulties of applying them further back.

Dr. K. Hruby, first assistant to Professor Lindner, demonstrated slides of vitreous and retinal detachments, the value of the Hruby lens on the Haag-Streit slit lamp and the new Zeiss slit lamp in the differential diagnosis of macular holes and cysts, and the " star " accessory to the slit lamp.

Visits were arranged to the Schönbrunn Palace, the Vienna Woods, and other famous places, and the party left Vienna with happy memories of the hospitality and enthusiasm of our hosts and their wives.

Graz.—Professor Böck (and his two chief assistants, Dr. Schlagenhauff and Dr. Hefel) demonstrated cases, performed operations, and reviewed the effects of certain new drugs. A girl of 4 years with iridocyclitis in her only eye had been treated with penicillin and 43 g. streptomycin with indifferent success. Vision was 6/60. Cortisone 1 ml. in 4 ml. saline, one drop hourly for 14 days, and then 3 times daily with ointment at night, produced a visual acuity of 6/6 in 8 weeks. An ammonia burn with local application of the patient's blood serum every ½ hr. showed a good result in 14 days. Intracapsular extraction is performed in the manner of Professor Lindner except that a retrobulbar injection is given with Corbasil. Penicillin is not injected. The Professor performed scleral resection on a boy of 10 years for what was considered to be a lower half traction detachment after an iridectomy for secondary glaucoma following chronic uveitis. This was whole-thickness as described in the manner of Professor Lindner. In a case of retinal detachment, Amsler's scheme for the recording of holes was employed. For small holes, non-perforating ½-mm. needles are used followed by perforating diathermy, and, for large holes, localization with a short needle and penetration with long needles to evacuate the fluid and prevent scleral necrosis.

Professor Böck also arranged enjoyable bus and cable-railway trips in the mountains, and we left Austria with a deep sense of gratitude for the warmth of our welcome.

STUDY TOUR TO BELGIUM, MAY, 1951

A party of nineteen, led by Mr. W. M. Muirhead (*Sheffield*), left London by private motor coach on May 8, 1951, to visit clinics in Brussels, Louvain, Nancy, and Strasbourg.

Brussels.—At the Eye Department of the University Hospital the party was received by Professor Coppez and his staff. After a tour of the clinic, the following papers were given :

In English.—" Retrolental Fibroplasia " by Dr. Zanen ; " Investigations on Intra-Ocular Vascular Pressures " by Dr. de Laet ; " Exophthalmometry " by Dr. Danis.

In French.—Mr. Williamson-Noble showed Kirby's film on " Cataract Extraction " ; Mr. Shapland spoke on " Scleral Resection for Detachment of Retina ".

On the following day a visit was paid to the Coppez private clinic, which contains thirty beds. Prof. Coppez gave details of his Thermometric Electrode, his talk being

based on an address given at a recent Oxford Congress. He also showed a film on "Lamellar Corneal Grafting and Elliot's Trephining".

Dr. Ectors, the chief neuro-surgeon of Belgium, gave a most interesting demonstration, and showed a collection of normal and pathological skull *x* rays taken during the last 15 years.

Louvain.—Professor Appelmans entertained the party with a programme of papers by his assistants.

Dr. Blockeel described his experience with electronic microscopy of the vitreous body.

Dr. de Niel described a case of bilateral glioma of the retina. One eye had been excised, the section showing a very large number of rosettes. The remaining eye had been treated by radiotherapy, with great success up to the present.

Dr. Michiels described a case of bilateral retinal angiomata treated by surgical diathermy.

Dr. de Peuter and Dr. Lebas described a case of rheumatoid polyarthritis associated with Sjögren's syndrome, in which cortisone and ACTH had had little effect.

Nancy.—Professor Thomas was a very enthusiastic host, and began by motoring out from Nancy in the hope of meeting us on the road.

In his operating theatre, the tables are fitted with a combined head-clamp and arm-rest, designed by him and made by Rupalley et Cie. He showed us several instruments, including the following:

(1) A kerato-pupillometer.
(2) A dynamometer—a modification of the Bailliart instrument.
(3) An instrument for measuring the capillary resistance of the conjunctiva.
(4) Conjunctival forceps, with needle guides, especially useful in corneo-scleral suturing.
(5) Fine polythene tubing for introduction into the naso-lacrimal duct.

Interesting eye cases were shown and operations were performed by the Professor, Mr. Shapland, Mr. Whiting, and Mr. Williamson-Noble. Mr. Foster later gave a talk in French to the general practitioners of the neighbourhood.

The next day further cases were shown. In one of these both eyes had been severely injured; one was removed and in the other an intracapsular cataract extraction was done, followed by a perforating corneal graft, which was very clear. Another case had a disciform keratitis treated successfully by lamellar grafting. A third had had a complete vitreous haemorrhage, and as no improvement had followed in 6 months, vitreous was removed from the affected eye and replaced by donor material.

Professor Jeandelize spoke of the value of vitamin C in the treatment of senile cataract, and papers were given by Messrs. Green, Moffatt, Roper-Hall, Shapland, and Williamson-Noble.

Strasbourg.—Here we were entertained by Professor Nordmann, Professor Redslob, and their staff. The Eye Clinic had been completely rebuilt by the Germans during the occupation, the Nazi Rector being an ophthalmologist, and as a result it is now very well equipped. The dark-rooms are painted in maroon, with blue desk lights. Amongst the instruments in the Out-Patient Department are the following:

(1) Amsler's placido-disk camera.
(2) Nordensen's fundus camera.
(3) Camera for anterior segment photography.
(4) Comberg adaptation test apparatus to test the powers of adaptation under the conditions of night-driving.

Once again papers were given by both the members of the staff of the clinic and the visitors. Professor Redslob showed a series of sections illustrating a case of bilateral anophthalmos, in which some small rests of the secondary optic vesicles could be found with a formation of pseudo-rosettes. He showed a series of slides illustrating the causes of failure in trephine and cyclodialysis, in which he mentioned:

(*a*) badly placed operation,
(*b*) infection,
(*c*) closing of the angle of the anterior chamber.

He also showed slides of sympathetic ophthalmia, and gave reasons for supporting the theory of its aetiology by infection spreading directly through the chiasma.

Professor Nordmann spoke on melanoma of the choroid, and gave arguments in favour of Masson's theory as opposed to Wolff's. Professor Klein and Professor Karly outlined their results in researches on optic nerve regeneration and on a condition of retinal degeneration associated with glial proliferation throughout the retina in rats born with this retinal anomaly.

The social side has not been mentioned; this would take too long, but there is no doubt that a motor coach is an ideal way of doing such a trip. Amongst the many advantages of this mode of travel is the fact that one is able to see so much more of the country than one would by train. It was a memorable and most enjoyable tour.

STUDY TOUR TO SPAIN AND FRANCE, SEPTEMBER, 1951

A party of twelve, led by Mr. J. E. M. Ayoub, paid a visit of six days to clinics in Barcelona, and went on to Lyons for a further three days. The principal hosts who arranged the programmes of work and relaxation were Count H. Arruga and Prof. Louis Paufique. They threw open their clinics and organized demonstrations, and also through their good offices the party was accommodated in most comfortable hotels and shown the places of interest in these cities.

Barcelona.—Count H. Arruga and Doctor A. Arruga demonstrated operations and films to illustrate details of technique. Professor Barraquer and Doctor Barraquer Moner also showed all aspects of their magnificent clinic, and held two operating sessions, a review of cases and results, and a film session, in which a selection of their large film library was used. Two visits were also paid to Professor Sorya at the University Eye Clinic; an interesting series of operations was demonstrated, and slides of unusual cases exhibited. The last day was spent in a visit to the Cusi establishment; besides witnessing all the processes involved in the manufacture of the famous ointments and medicines, the party was shown the large museum of medical and pharmaceutical books, drawings, and implements.

Lyons.—Prof. Bonnet of the Hôpital Edouard Herriot and Prof. Louis Paufique of the Hôpital de l'Antiquaille were joint hosts, and nothing could have exceeded the warmth of their hospitality, the pains they took in making the visit instructive, and the sense of friendliness which they imparted throughout the visit.

Techniques Observed

(1) *Arruga.*—Cataract extractions were done in the patients' beds, Arruga going from room to room. His assistant carried a bag in which was a dry sterilized container with a set of instruments, and his son held the lamp. Arruga invariably performed an intracapsular extraction, using the forceps and speculum of his own design except on one occasion when a hard capsule prevented him from gripping it with his own forceps and he successfully used toothed forceps. In his technique he merely uses the expressor for steadying the eye, and mainly relies on the pull of the forceps; he uses three simple corneoscleral sutures, the central one after the section, the lateral ones after the iris replacement, and he makes two basal iridotomies, situated between the sutures. All the instruments and needles are made by Grieshaber.

The speed of his detachment operations is remarkable; these are done in the outpatient theatre, the patients being sent home immediately after operation to rest in bed

for 2 to 3 weeks. He has obviously carefully studied the fundus the previous day. He marks the meridian of the hole with ink and quickly nips an opening into Tenon's capsule, and the assistant inserts the speculum. Arruga has already made a mental estimate of the distance from the limbus for the first diathermy application, as he does this without measurement, and only uses his ophthalmoscope to check the reaction and its position. In practically every case we saw, the reaction was right on the hole. He would then apply one or two spots around the first, and finally a lesser quantity of diathermy around them by rubbing the applicator over the surface. He pays little attention to the actual milliamperage or duration, but judges the dosage from the reactions. He punctures to let out fluid, and if there is a large balloon, injects 1 to 2 ml. air into the vitreous. He makes the eye quite hard, and he is convinced that this does press the retina back into its place.

In performing dacryocystorhinostomy, he makes his first opening through the bone of the lacrimal fossa with a 1-cm. trephine, enlarges the hole, and cuts flaps. The posterior flap of mucosa is sutured to the posterior flap of the sac ; the anterior flaps are sutured also to the subcutaneous tissues to secure a wide initial opening.

Arruga's operating technique is speedy, but gives an impression of leisure ; he is very simple in his execution, and the whole atmosphere is one of quietness and delicacy.

(2) *The Barraquers.*—The clinic is, of course, astonishing, and totally unlike any English one, yet on mature consideration one realizes that it is very efficient, and that an immense amount of planning has contributed to its efficient working. The operating theatre, though full of gadgets and dials, with the surgeon sitting in an armchair and never rising from it, is admirably run with most efficient staff work ; it is clear that everything is designed to conserve the operator's freshness, and to relieve him from all unnecessary movement. The hidden loudspeaker, playing throughout, seemed odd at first, for during one extraction Barraquer Moner started to the strains of Wagner's Anvil Chorus, continued through Mendelssohn's Spring Song, and finished with Bach's Toccata and Fugue in D. Yet all these tunes were rhythmical, and had a soothing effect.

In cataract extractions, the erisiphake was invariably used with success, though it was obvious that its use requires considerable experience. One peripheral iridectomy was made and three direct corneoscleral sutures used, the central one placed after the section, the lateral ones at the end of the operation.

On more than one occasion Barraquer Moner extracted both lenses consecutively, for reasons of economy.

His technique with keratoplasty was excellent but orthodox ; he prefers direct suturing of the graft.

Barraquer Moner says that he is only interested in operations around the anterior chamber. All others are done in an adjoining theatre, as the main theatre would be quite unsuitable for any operation not compatible with the surgeon sitting above the patient's head. He did his first cataract extraction at the age of 12 years, having assisted his father from the age of 10. The operations we saw done were technically perfect, and we were all impressed with his complete control and certainty of use of his instruments. One felt, however, that the clinic revolved around surgery.

In the hands of Doctor Martin, the relaxation obtained by curare was excellent. He states that there have been no unpleasant effects in over a thousand cases.

(3) *Professor Sorya.*—He did three extractions, using Llorca's erisiphake, a small instrument where vacuum is controlled by a firm rubber teat. This was successful in two cases, and in the third the capsule was broken. He did two trephinings, and a dacryocystorhinostomy.

(4) *Professor Paufique.*—His surgery was excellent. He did several extractions, in one of which the lens was subluxated. In this he used a scoop without loss of vitreous,

and his technique in this case was perfect. He also uses three corneoscleral sutures. He demonstrated lamellar grafting, and though he did not show us a total graft, we saw his method of using his modification of Desmarres knife.

One was struck by the high quality of his instruments, most of which were made in France. All the surgeons we saw used much finer and smaller-toothed forceps than those popular in England, and these finer forceps are essential for corneal suturing, in both extraction and keratoplasty.

(5) *Professor Bonnet.*—He did two operations for us. The first was the radical removal of a malignant melanoma of the right middle turbinate, involving the orbit and frontal sinus, which proved to be an extensive operation ; it was successfully concluded, and it appeared that the tumour had been well delimited. This patient recovered uneventfully, and left hospital with very little scarring, and complete relief of her exophthalmos. His second case was a plastic operation of moving a full-thickness pedicle graft to repair the eyelids, cicatrized by a chemical burn. The cornea was also involved, and the restoration of the lids was a preliminary to a keratoplasty, for which the patient would be transferred to Paufique. Professor Bonnet, who was originally a general surgeon and had had much experience of facial work in the two wars, is obviously very skilled at this type of work. We did not, unfortunately, have the pleasure of seeing him do any intraocular operations.

He also showed a selection of his huge collection of drawings and paintings of fundus conditions, which are his own work. They range over the whole field of vascular changes, retinopathies, and degenerations, and reveal Professor Bonnet's versatility and wide interests in the medical aspects of ophthalmology.

(6) *Doctor Hugonnier.*—In performing two scleral resections for us, he demonstrated a lamellar resection, and then put down two lines of diathermy, one along the site of the resection, and one row behind it. A diathermy puncture in the same region let out intra-retinal fluid.

In each centre the aims of this party of learning first-class techniques of keratoplasty, detachment surgery, and cataract extraction, were fully achieved. There is no doubt that much can be learnt in these clinics, and the party is deeply indebted to the principals and assistants for their efforts in making the tour a success.

BOOK REVIEWS

Die Trübungsformen des Menschlichen Linse (Various Forms of Cataract in the Human Lens). By H. SAUTTER. 1951. Georg Thieme Verlag, Stuttgart. Pp. viii, +140, 191 illus. (some col.). (D.M. 49.80; 87*s.* 6*d.*)

This slim volume sets out to describe concisely and yet as completely as possible the morphology of the various kinds of opacification of the lens as well as to give an account of the modern views of their causation.

Such a book stands or falls largely by its illustrations; one need not say more than that they are in the same class as those in Vogt's Atlas. The majority of the pictures are in half-tone, but some are in colour; they are nearly all slit-lamp drawings, but here and there, scattered through the text, are photomicrographs of the pathological lesions under discussion.

The monograph concludes with a very useful bibliography of the more modern literature. All in all a very good book.

Tumours of the Eye. By A. B. REESE. 1951. Cassell, London. Pp. 574, 283 figs, 985 refs. (7 *guin.*)

The primary aim of this beautifully produced book is to present to practising ophthalmologists a comprehensive evaluation of present-day knowledge of ocular neoplasms, a subject which has advanced considerably since La Grange's book appeared in 1901. It is also intended to be of value to pathologists. Since the work is based upon the personal observations and convictions of a writer with great experience in both the clinical and pathological fields of ophthalmology it is hardly surprising that it succeeds admirably in both these objects.

The book is written clearly and concisely and does not suffer from the fault, common in ophthalmological literature, of quoting all contradictory evidence without careful consideration of the merit of the publications; each paper quoted has obviously been read thoroughly and the material is carefully assessed and skilfully woven into the pattern of the writer's balanced arguments.

The arrangement of the subject matter is commendable. The neoplasms are considered according to their tissue type rather than under the more usual but artificial headings of their anatomical sites of election. Thus in seventeen chapters the author deals with epithelial tumours, retinoblastoma, glioma, meningioma, tumours of the peripheral nerves, pigmented tumours, angiomatous tumours, leiomyoma, etc., and each group is considered from the point of view of incidence, clinical appearance, histopathology, differential diagnosis, prognosis, and treatment.

The chapter on pigmented tumours contains a valuable assessment of the various hypotheses dealing with their histogenesis, a subject which appears chaotic to the student and confusing even to the expert. The data is arranged in a masterly fashion, and although some will not agree with the conclusions and final classification, all the arguments are carefully marshalled and fairly presented. The section dealing with orbital pseudo-tumours is particularly good.

In the opinion of the reviewer there are one or two small defects which might be improved in future editions. Since all "carcinomata" are in fact epithelial tumours, a pathologist might take exception to the author's use of "epitheliomata" for malignant tumours of the skin; the term "epidermoid carcinomata" is to be preferred. While there are eleven pictures of intra-epithelial cysts of the anterior uvea there are no

illustrations of some important lesions, such as meningioma of the optic nerve; the section on myeloma is somewhat inadequate, and solitary plasmacytoma is not mentioned. The difficulty in diagnosing iris biopsies in cases of suspected malignancy should have been discussed, and benign lymphomata of the conjunctiva might, perhaps, have received more than a passing reference. On p. 237, Fig. 115C should read 115B.

These, however, are very minor points, for the book is undoubtedly excellent and will long remain the standard work on the subject. Despite its high cost no consultant oculist or comprehensive medical library should be without it. The author is to be congratulated on a fine contribution to ophthalmic literature.

Les Tumeurs Primitives de L'Orbite. By GUY OFFRET. *1951. Masson, Paris.* Pp. 580, 290 figs, bibl. (66*s*.)

This is the most recent addition to a series of notable books upon ophthalmological subjects published under the auspices of the Société française d'Ophtalmologie. Professor Guy Offret is also part-author of a former volume in the series on corneal grafts and grafting.

In his introduction Professor Offret states that, despite progress in diagnostic and explorative techniques, the diagnosis of orbital tumours remains one of the most difficult in the realm of ophthalmology and his aim in preparing the present work has been to resolve some of this difficulty and obscurity by presenting as a cogent whole, the symptomatology, diagnosis, histopathology, and treatment of primary orbital tumours. The resulting volume has been carefully planned and executed ; the author has drawn upon the vast literature and upon his own wide experience to produce a balanced and integrated clinical and pathological study in which outworn and speculative ideas have been abandoned and adequate space devoted to detailed histopathological description.

The preliminary chapters are devoted to a systematic account of the symptoms and signs of orbital tumours. The value of radiography in diagnosis is emphasized and the advantages of tomography, in eliminating the false shadows which make plain radiographs of the orbit and nasal sinuses difficult and deceptive, are amply illustrated in a manner intelligible even to the uninitiated. The injection of air as a contrast medium into the orbital tissues and into Tenon's capsule is described and illustrated, and reference is made to cerebral angiography as an occasional means of revealing tumours not otherwise discernible. On the whole the author favours biopsy, believing that with careful technique the diagnostic advantage outweighs the danger of dissemination.

The statistical study which occupies Chapter III culminates in an impressive analysis of 676 surgically and histologically verified tumours mostly from French and American sources. It is doubtful if such a large series, carefully analysed, exists anywhere else in the literature.

Each of the subsequent sections is devoted to tumours arising from a particular tissue—osseous, vascular, neural, etc. This is convenient enough for the most part, but leads to some difficulties with myeloid tumours and reticulosarcomata. The subject matter is explored with meticulous care and each section enriched with detailed case histories. The author employs the term tumour in a wide sense to include almost all space-occupying lesions other that those of inflammatory origin. The use of the designation 'peripheral glioma' for Schwannoma and neurilemmona will induce in pathologists, at least, a sense of frustration, but it is the logical outcome of the view, not universally acceptable, that Schwann cells and the arachnoid endothelial cells are of neuroectodermal origin.

The 290 figures are mostly photomicrographs of good quality, some of which, however, have suffered a loss of detail in reproduction: it is perhaps a pity that the magnification is not stated. The bibliography contains over 1,000 references, and it is

significant of the growing interest in orbital tumours that the majority are to works published since 1930. It is to be regretted that an index was not thought necessary.

Finally, the fact that the text is in French need deter no one, for the author's style is lucid and his astringent didacticism brings his wide and detailed knowledge into sharp focus.

Ophthalmology. By ARNO E. TOWN. 1951. Henry Kimpton, London. Pp. 510, illus., index. (70*s*.)

The appearance of yet another book on ophthalmology to provide, in the words of the preface, for the needs of the undergraduate student and the general practitioner, calls, we feel, for some justification, in view of the large numbers of excellent works already available in the English language to meet such a demand. We have searched this work in vain for any features upon which such a plea of justification could be based. The book, we feel, is completely lacking in balance. It is emphasized in the preface that the basic fundamentals of diagnosis and therapy are encompassed in the physiology of vision, this appears to be muddled thinking, and we cannot but think that if part of the space devoted to discussions on the visual pigments, electro-retinography, and the like, had been devoted to a consideration of the basic physiology of the eye itself and of its components, the book would be of greater value to those for whom it is designed.

The same defects mar those sections devoted to clinical ophthalmology, where the aim seems to have been to mention as many clinical disease-entities as possible, a mode of presentation which, in a work of this size, must preclude anything more than a superficial, and often tabulated, summary of the salient features of each, and which, while useful to the erudite student, has little value for the beginner.

The general standard of accuracy is unfortunately not of a high level. Thus, for example, on p. 85 the editors of the first series of "Modern Trends in Ophthalmology" appear under the pseudonyms Riley and Sarsby, on p. 173 we read of the glands of Zeiss, on p. 339 of Coat's disease, on p. 239 that muscae volitantes are shadows cast on the retina by corpuscles coursing through the retinal blood vessels, on p. 341 that it is the passage of vitreous through a hole in the retina which leads to the formation of a detachment, on p. 352 that Leber's disease occurs almost exclusively in males, having been transmitted through females in whom the disease was not manifest, and on p. 389 that, while Duane's syndrome comprises many aberrations of ocular motility, retraction of the globe does not apparently occur in any circumstances.

The illustrations, a very large number of which has been taken from standard text-books and journals and are in half-tone, are good and accurately legended.

NOTES

OPHTHALMOLOGICAL SOCIETY OF AUSTRALIA (B.M.A.)

ELEVENTH ANNUAL MEETING, 1951

THE eleventh Annual Meeting of the Ophthalmological Society of Australia (B.M.A.) was held at Hobart, Tasmania, under the presidency of Dr. J. Bruce Hamilton during the week ending November 17, 1951. This meeting was designated the Jubilee Congress of the Society in honour of the centenary year of the Commonwealth of Australia.

His Excellency the Governor, Sir Ronald Cross, and Lady Cross gave a reception at Government House and on a subsequent evening the Governor opened the congress with an inspiring address.

The meeting was attended by two distinguished guests from overseas, Dr. Henrik Sjögren (*Sweden*), and Mr. Arthur Lister (*London*), who was accompanied by Mrs. Lister.

Forty-four members from the various States of the Commonwealth were present, namely, Queensland 1, New South Wales 17, Victoria 19, Tasmania 5, Western Australia 1. Dr. Sjögren read papers on "Kerato-conjunctivitis Sicca" and "Some Dystrophies of the Pigment Layer of the Retina". Mr. Lister spoke on "Scleral Resection for Retinal Detachment" and "The Surgery of Congenital Glaucoma". Members of the Society contributed papers on "Anomalies of the Oblique Muscles", "Retrolental Fibroplasia", "Retinal Cysts", and "Facial Twitching". Cinematograph films were shown by courtesy of Dr. J. N. R. Carter, and among them was one in colour on "Lamellar Corneal Grafts", made by Professor Louis Paufique of Lyons. This film was generously lent by Professor Paufique through the courtesy of Dr. Cedric Cohen, who exhibited it and translated the sound track.

Visits were made to the Tasmanian Institute for the Deaf and Blind and to the Sight-Saving School, and for a few days before and after the congress, members and guests made several tours to places of interest and scenic beauty.

The Lord Mayor of Hobart gave a reception to members and guests, and the Premier, Mr. Robert Cosgrove, entertained them at a State luncheon. Great hospitality was received through the courtesy of the Minister for Health, Dr. David Turnbull, and from Tasmanian members and their wives. At the Annual Dinner, held at Hadley's Hotel, it was announced by the President that Dr. Sjögren and Mr. Lister had been elected honorary members of the Society. Members and guests left Tasmania with an abiding appreciation of the abundant

kindness which had been shown them, having greatly enjoyed the natural beauties and quiet charm of this lovely island.

The following officers were elected for the coming year:

President: - Dr. George Brew (*Melbourne*).
Vice-President: Dr. A. L. Tostevin (*Adelaide*).
Hon. Treasurer: Dr. A. E. F. Chaffer (*Sydney*).
Hon. Secretary: Dr. Arnold Lance, *135, Macquarie Street, Sydney.*

The twelfth Annual Meeting will be held at Melbourne in August, 1952, in conjunction with the eighth session of congress of the British Medical Association in Australia.

MR. F. W. LAW, M.D., F.R.C.S., has been promoted to the rank of *Commander* (*Brother*), and MR. H. B. STALLARD, M.B.E., LL.D., M.D., F.R.C.S., to the rank of *Officer* (*Brother*) of the Venerable Order of the Hospital of St. John of Jerusalem.

OXFORD OPHTHALMOLOGICAL CONGRESS, 1952

THE next meeting will be held in Oxford on Thursday, Friday, and Saturday, July 3, 4, and 5, 1952. The Doyne Lecture will be delivered by Dr. Dorothy Campbell (*Coventry*). This year members will reside in Balliol College.

COMMONWEALTH AND EMPIRE HEALTH AND TUBERCULOSIS CONFERENCE, 1952

THE third Commonwealth and Empire Health and Tuberculosis Conference will be held in London at the Central Hall, Westminster, from July 8-13, 1952. The first three days will be devoted to lectures and discussions, and the last three to visits to sanatoria, hospitals, and clinics. Further information may be had from the Secretary-General, National Association for the Prevention of Tuberculosis, Tavistock House North, Tavistock Square, London, W.C.1.

ERRATUM

Brit. J. Ophthal. (1952). **36,** 110, line 16, for "sympathetic" read "parasympathetic".